SEA-BIRD SCIENTIFIC

SBE Sea-Bird Electronics

User Manual

Release Date: 02/12/2015

SBE 45 MicroTSG Thermosalinograph

Conductivity and Temperature Monitor
with RS-232 Interface

Manual version	• 019
Firmware version	• 1.1b & later
Software versions	• Seasave V7 7.23.2 & later • SBE Data Processing 7.23.2 & later

CE

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Limited Liability Statement

Extreme care should be exercised when using or servicing this equipment. It should be used or serviced only by personnel with knowledge of and training in the use and maintenance of oceanographic electronic equipment.

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Declaration of Conformity

Sea-Bird Electronics, Inc.
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DECLARATION OF CONFORMITY

Manufacturer's Name: **Sea-Bird Electronics**
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Device Description: Various Data Acquisition Devices and Sensors

Model Numbers:

3S	3F	3plus	4C	4M	5T	5P	5M	7
8	9plus	11plus	14	16plus V2	16plus-IM V2		17plus V2	18
19plus V2	21	25plus	26plus	27	29	32	32C	32SC
33	35	35RT	36	37-IMP	37-IM	37-SMP	37-SM	37-SIP
37-SI	38	39	39-IM	39plus	41	41CP	43	43F
44	45	49	50	52-MP	53BPR	54	55	56
63	SIM	ICC	IMM	PDIM	AFM	90488	90204	90402
90504	Glider Payload CTD		NiMH Battery Charger and Battery Pack					

Applicable EU Directives:
Machinery Directive 98 / 37 /EC
EMC Directive 2004 / 108 /EC
Low Voltage Directive (73 / 23 /EEC) as amended by (93 / 68 /EEC)

Applicable Harmonized Standards:
EN 61326-1:2006 Class A Electrical Equipment for Measurement, Control, and Laboratory Use, EMC Requirement – Part 1: General Requirements
(EN 55011:2007 Group 1, Class A)

EN 61010-1:2001, Safety Requirements for Electrical Equipments for Measurement, Control, and Laboratory Use – Part 1: General Requirements

Declaration based upon compliance to the Essential Requirements and Letter of Opinion from CKC Certification Services, LLC., Notified Body 0976

I, the undersigned, hereby declare that the equipment specified above conforms to the above European Union Directives and Standards.

Authorized Signature:

Name: Nordeen Larson

Title of Signatory: President

Date: 3 September 2013

Place: Bellevue, WA

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Section 1: Introduction

This section includes a Quick Start procedure, and photos of a standard SBE 45 MicroTSG shipment.

About this Manual

This manual is to be used with the SBE 45 MicroTSG Conductivity and Temperature Monitor. It is organized to guide the user from installation through operation and data collection. We've included detailed specifications, command descriptions, maintenance and calibration information, and helpful notes throughout the manual.

Sea-Bird welcomes suggestions for new features and enhancements of our products and/or documentation. Please contact us with any comments or suggestions (seabird@seabird.com or 425-643-9866). Our business hours are Monday through Friday, 0800 to 1700 Pacific Standard Time (1600 to 0100 Universal Time) in winter and 0800 to 1700 Pacific Daylight Time (1500 to 0000 Universal Time) the rest of the year.

Quick Start

Follow these steps to get a Quick Start using the MicroTSG.
The manual provides step-by-step details for performing each task:

1. Perform pre-check procedures (see *Sections 3* and *4*):
   A. On the Configuration Sheet (in the manual), check the factory-set power-up mode jumper setting. For a description of how the jumper setting affects operation, see *Power-Up Jumper Check* in *Section 3: Installing System*.
   B. Test power and communications.
   C. Establish setup and operating parameters.
   D. Check status (**DS**) and calibration coefficients (**DC**) to verify setup.

2. Deploy the MicroTSG (see *Sections 3*, *4*, and *5)*:
   A. Verify the AF24173 Anti-Foulant Device is installed.
   B. Install the MicroTSG.
   C. Send commands to run the system.

Note:
See the Interface Box manual for operation of the MicroTSG with the Interface Box. The Interface Box can be added to the system at any time, and does not need to be part of the original MicroTSG order.
- **The Interface Box must be placed in a mode to communicate with the MicroTSG (Connect45 command) before you send commands through the Interface Box to the MicroTSG.**

Unpacking MicroTSG

Shown below is a typical MicroTSG shipment.

MicroTSG

I/O cable

Spare parts kit

Conductivity cell cleaning solution (Triton X-100)

Software, and Electronic Copies of Software Manuals and User Manual

Section 2: Description of MicroTSG

This section describes the functions and features of the MicroTSG, including:
- System description
- Specifications
- Dimensions and connector
- Sample timing
- Baud rate, cable length, and power requirements
- Optional remote temperature sensor

System Description

The SBE 45 MicroTSG is an externally powered, high-accuracy, conductivity and temperature monitor, designed for shipboard determination of sea surface (pumped-water) conductivity and temperature.

Communication with the MicroTSG is over an internal, 3-wire, RS-232C link, providing real-time data transmission. Commands can be sent to the MicroTSG to provide status display, data acquisition setup, data acquisition and display, and diagnostic tests. User-selectable operating modes include:

- **Polled sampling** – On command, the MicroTSG takes one sample and sends the data to the computer.
- **Autonomous sampling** – At pre-programmed intervals, the MicroTSG samples and sends the data to the computer. The MicroTSG does not enter quiescent (sleep) state between samples.
- **Serial Line Sync** - A pulse on the serial line causes the MicroTSG to wake up, sample, and enter quiescent (sleep) state automatically.

Calibration coefficients stored in EEPROM allow the MicroTSG to transmit data in engineering units. The MicroTSG retains the temperature and conductivity sensors used in the SBE 21 Thermosalinograph, but has improved acquisition electronics that increase accuracy and resolution, and lower power consumption. The MicroTSG's aged and pressure-protected thermistor has a long history of exceptional accuracy and stability (typical drift is less than 0.002 °C per year). Electrical isolation of the conductivity electronics eliminates any possibility of ground-loop noise.

The MicroTSG's internal-field conductivity cell is unaffected by external fouling. A plastic cup with O-ring retainer at one end of the cell retains the expendable AF24173 Anti-Foulant Device.

An **optional AC- or DC-powered 90402 - SBE 45 Power, Navigation, and Remote Temperature Interface Box** provides:

- Power and an opto-isolated RS-232C interface for the MicroTSG
- An opto-isolated NMEA receiver for an optional NMEA navigation device which supports NMEA 0183 protocol, outputting data in GGA, GLL, RMA, RMC, or TRF format (NMEA navigation device not supplied by Sea-Bird)
- Power and an RS-232C interface for an optional **SBE 38** remote temperature sensor
- An RS-232C computer interface

Decoded Latitude, Longitude, date, and time and SBE 38 temperature data are appended to the MicroTSG data stream in the Interface Box. The data is transmitted to the computer for storage and/or display.

Note:
See the Interface Box manual for operation of the MicroTSG with the Interface Box. The Interface Box can be added to the system at any time, and does not need to be part of the original MicroTSG order.
- **The Interface Box must be placed in a mode to communicate with the MicroTSG (Connect45 command) before you send commands through the Interface Box to the MicroTSG.**

The MicroTSG is supplied with a powerful Windows software package, Seasoft© V2, which includes:

- **Seaterm** – terminal program for easy communication and data retrieval, can send commands to the MicroTSG to provide status display, data acquisition setup, data display and capture, and diagnostic tests.
- **Seasave V7** – program for acquiring, saving, and displaying real-time or archived data.
- **SBE Data Processing** – program for calculation and plotting of conductivity, temperature, data from auxiliary sensors, and derived variables such as salinity and sound velocity.

Notes:
- Help files provide detailed information on the software.
- Software manuals on CD-ROM contain detailed information on Seasave V7 and SBE Data Processing.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our website. See our website for the latest software version number, a description of the software changes, and instructions for downloading the software.

Specifications

	Temperature (°C) [1]	Conductivity (S/m)	Salinity (PSU), typical
Measurement Range	-5 to +35	0 to 7 (0 to 70 mS/cm)	-
Initial Accuracy	± 0.002	± 0.0003 (0.003 mS/cm)	± 0.005
Typical Stability (per month)	0.0002	0.0003 (0.003 mS/cm)	0.003
Resolution [2]	0.0001	0.00001 (0.0001 mS/cm)	0.0002
Sensor Calibration Range	+1 to +32	0 to 6; physical calibration over the range 2.6 to 6 S/m, plus zero conductivity (air)	-
Counter Time-Base	Quartz TCXO, ±2 ppm per year aging; ±5 ppm vs. temperature (-5 to +30 °C)		
Sampling Speed	User-programmable 1-sec to 9-hour intervals (minimum dependent on setup)		
Input Power	8 - 30 VDC Quiescent (sleep) Current: 10 microamps Operating Current: 34 milliamps at 8 VDC 30 milliamps at 12-30 VDC		
Materials	PVC housing		
Recommended Flow Rate	10 to 30 milliliters/second (0.16 to 0.48 gallons/minute)		
Maximum Safe Operating Pressure	34.5 decibars (50 psi)		
Weight	4.6 kg (10.2 lbs)		

Notes:

[1] Temperature specifications above are for MicroTSG's temperature sensor. For optional remote temperature sensor (SBE 38), which can be integrated with optional 90402 Interface Box -

Measurement range: -5 to +35 °C — Initial accuracy: 0.001 °C
Resolution: 0.0003 °C — Calibration: -1 to +32 °C
Typical stability: 0.001 °C in 6 months, certified

[2] Resolution

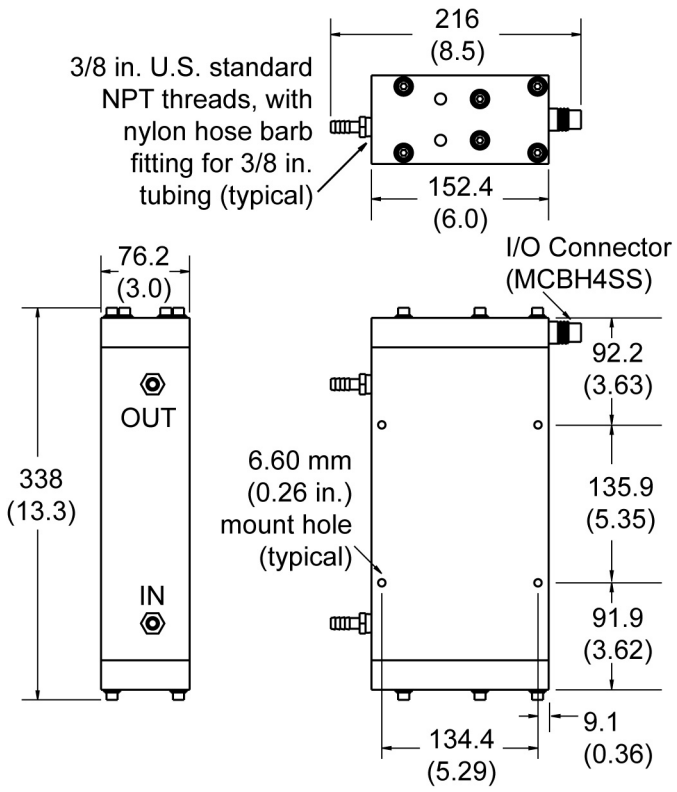
Typical RMS noise with fixed resistors on temperature and conductivity inputs:

NCycles *	Temperature (°C)	Conductivity (S/m)	Salinity (psu)	Sound Velocity (m/sec)
1	0.000190	0.000014	0.00027	0.00066
2	0.000170	0.000010	0.00016	0.00057
4	0.000150	0.000005	0.00015	0.00055
8	0.000087	0.000005	0.00009	0.00033
16	0.000078	0.000004	0.00007	0.00025

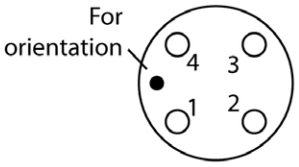
* **NCycles** = number of measurements to average per sample.

Dimensions and Connector

Dimensions in millimeters (inches)



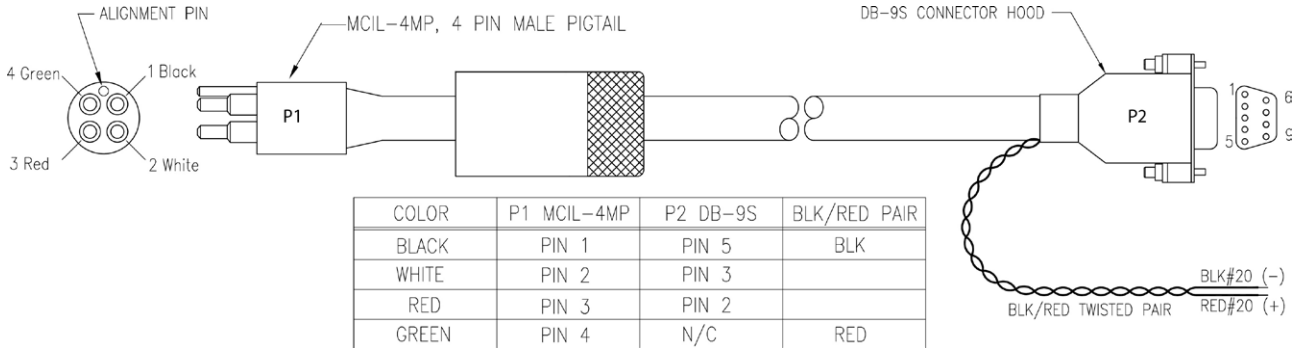
MCBH4SS



Pin	Signal
1	Common
2	RS-232 RX
3	RS-232 TX
4	External power in (8 - 30 VDC)

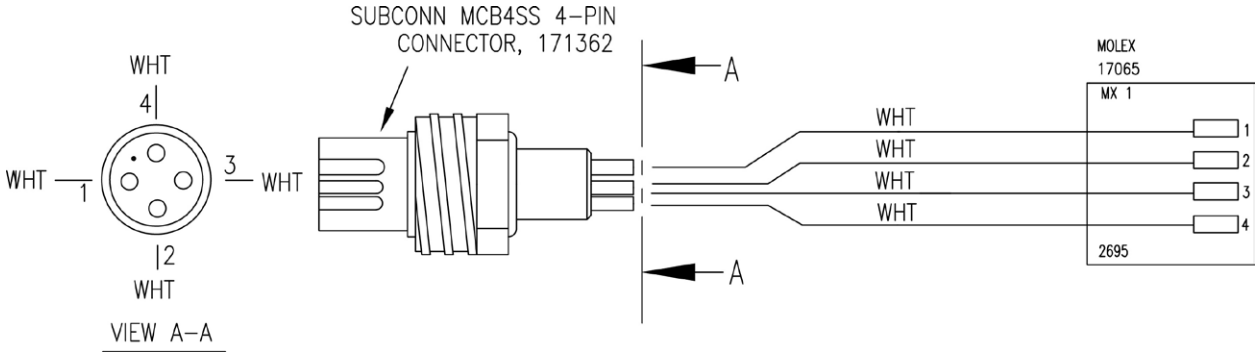
Cable and Wiring

Cable Wiring – Drawing 32756



COLOR	P1 MCIL-4MP	P2 DB-9S	BLK/RED PAIR
BLACK	PIN 1	PIN 5	BLK
WHITE	PIN 2	PIN 3	
RED	PIN 3	PIN 2	
GREEN	PIN 4	N/C	RED

Connector Wiring – Drawing 41053



Sample Timing

The time to acquire the temperature and conductivity varies, depending on the mode of operation.

Note:
See *Command Descriptions* in *Section 4: Setting Up MicroTSG* for descriptions of **AutoRun=**, **Go**, **SingleSample=**, **NCycles=**, and **Interval=**.

Polled Sampling Mode

Polled Sampling Mode is in effect when:
- PCB J1 jumper is set to Normal or Autopower, **AutoRun=N**, and sampling is started with **Go** (if **SingleSample=Y**) or with a polled sampling command

Time from end of take sample command to beginning of reply (seconds)
= (**NCycles** * 0.1336) + 0.459

Autonomous Sampling Mode

Autonomous Sampling Mode is in effect when:
- PCB J1 jumper is set to Normal or Autopower, **AutoRun=Y**, and **SingleSample=N**, ***or***
- PCB J1 jumper is set to Normal (pins 2 and 3), **AutoRun=N**, **SingleSample=N**, and sampling is started with **Go**

Time to acquire temperature and conductivity (seconds)
= (**NCycles** * 0.1336) + 0.287

Serial Line Sync Mode

Serial Line Sync Mode is in effect when:
- PCB J1 jumper set to Normal (pins 2 and 3), **AutoRun=Y**, and **SingleSample=Y**

Time from wake-up to beginning of reply (seconds)
= (**NCycles** * 0.1336) + 1.643

Total Sampling Time

Once temperature and conductivity are acquired, the time to calculate the desired parameters is not a function of the mode of operation:
- Time to compute temperature = 8.8 msec
- Time to compute conductivity = 15.4 msec
- Time to compute salinity = 83 msec
- Time to compute sound velocity = 35 msec

Total time required for sample =
time to acquire temperature and conductivity
+ time to compute selected parameters
+ time to transmit computed parameters

Notes:
- The time to transmit computed parameters is dependent on baud rate. See *Baud Rate, Cable Length, Power, and Data Transmission Rate*.
- For autonomous sampling, if the total time required for the sample is greater than the user-input sample interval (**Interval=**), the MicroTSG begins the next sample as soon as it finishes transmitting the current sample.

Baud Rate, Cable Length, Power, and Data Transmission Rate

Baud Rate, Cable Length, and Data Transmission Rate

Notes:
- Baud rate is set with **Baud=**.
- Real-time output rate is set with **Interval=**.
- Output format is set with **OutputCond=**, **OutputSal=**, and **OutputSV=**.

See *Command Descriptions* in *Section 4: Setting Up MicroTSG* for command details.

The rate that data can be transmitted from the MicroTSG is dependent on the amount of data to be transmitted per scan and the serial data baud rate:

Time to transmit data =
(number of characters * 10 bits/character) / baud rate

where

Number of characters is dependent on the included data and output format (see *Data Output Format* in *Section 4: Setting Up MicroTSG*). Add 2 to the number of characters shown in the output format, to account for the carriage return and line feed at the end of each scan. Include decimal points, commas, and spaces when counting the number of characters.

Note that the MicroTSG transmits data **after** it has completed the previous sample and **before** it starts the next sample. See *Sample Timing* above for information on sampling time.

The length of cable that the MicroTSG can drive to transmit real-time data is also dependent on the baud rate. The allowable combinations are:

Maximum Cable Length (meters)	Maximum Baud
800	1200
400	2400
200	4800 (factory set default)
100	9600
50	19200
25	38400

Example –

What is the minimum transmission time over 100 m of cable with **OutputCond=Y**, **OutputSal=Y**, **OutputSV=Y**, and **OutputFormat=0**?

With 100 meters of cable, the MicroTSG requires a baud rate of 9600 or less.
Number of characters (from *Data Output Format* in *Section 4: Setting Up MicroTSG*) =
8 (T) + 2 (comma & space) + 8 (C) + 2 (comma & space) + 8 (salinity) + 2 (comma & space) + 8 (sound velocity) + 2 (carriage return & line feed) = 40
Time required to transmit data = (40 characters * 10 bits/character) / 9600 = 0.042 seconds = 42 msec

What is the minimum **total** time required per sample (**Interval=**), if averaging 4 measurements/sample (**NCycles=4**) and operating in Autonomous Sampling Mode?

In Autonomous mode, time to acquire T and C (from *Sample Timing* above)
= (**NCycles** * 0.1336) + 0.287 = (4 * 0.1336) + 0.287 = 0.82 seconds
Total sampling time
= time to acquire T and C + time to compute parameters (from *Sample Timing* above) + time to transmit data
= 0.82 + (.0088 + .0154 + .083 + .035) + .042 = 1.00 second
Therefore, set **Interval=1**, transmitting 1 sample every second.

Power and Cable Length

Note:
Common wire resistances:

Gauge	Resistance (ohms/foot)
12	0.0016
14	0.0025
16	0.0040
18	0.0064
19	0.0081
20	0.0107
22	0.0162
24	0.0257
26	0.0410
28	0.0653

There are two issues to consider:

- Limiting the IR loss to 1 volt; higher IR loss will cause the MicroTSG to transmit data that does not meet the RS-232 communication standard.
- Supplying enough power at the power source so that sufficient power is available at the instrument after considering IR loss.

Looking at each issue separately:

Limiting IR Loss to 1 Volt

The limit to cable length is typically reached when the maximum current times the power common wire resistance is more than 1 volt.

V_{limit} = 1 volt = IR_{limit}
Where I is the current required by the MicroTSG (34 milliamps at 8 VDC; see *Specifications* above).

Maximum cable length = R_{limit} / wire resistance per foot

Example – For 18 gauge wire, what is the maximum distance to transmit power to the MicroTSG? If this the controlling factor for maximum cable length if wanting to transmit at 1200 baud?

For 34 milliamp current, $R_{limit} = V_{limit} / I$ = 1 volt / 0.034 amps = 29 ohms
For 18 gauge wire, resistance is 0.0064 ohms/foot.
Therefore, maximum cable length is 29 ohms / 0.0064 ohms/foot = 4531 feet = 1381 meters.
Note that 1381 meters > 800 meters (maximum distance MicroTSG can transmit data at 1200 baud), so IR loss is not controlling factor for this example.

Example 2 – Same as above, but there are 4 MicroTSGs powered from the same power supply.

$R_{limit} = V_{limit} / I$ = 1 volt / (0.034 amps * 4 MicroTSGs) = 7.35 ohms
Therefore, maximum cable length is 7.35 ohms / 0.0064 ohms/foot = 1148 feet = 350 meters (this is cable length to MicroTSG furthest from power source).

Supplying Enough Power to MicroTSG

Another consideration in determining maximum cable length is supplying enough power at the power source so that sufficient voltage is available, after the IR loss in the cable, to power the MicroTSG.

Example – For 18 gauge wire, what is the maximum distance to transmit power to the MicroTSG if using a 8.5 volt power source to supply power?
Is this the controlling factor for maximum cable length if wanting to transmit at 1200 baud?

MicroTSG's input power specification is 8 – 30 volts. Therefore, a 0.5 volt IR drop (8.5 volts – 8 volts) would still provide enough power to MicroTSG.
V = IR 0.5 volts = (.034 amps) * (0.0064 ohms/foot * cable length) Cable length = 2297 ft = 700 meters
Note that 700 meters < 800 meters (maximum distance MicroTSG can transmit data at 1200 baud), so IR drop in power is controlling factor for this example. Using a higher voltage power supply or a different wire gauge (12, 14, or 16 gauge) would provide sufficient power at MicroTSG to allow an 800 meter cable length.

Example 2 – Same as above, but there are 4 MicroTSGs powered from the same power supply.

V = IR 0.5 volts = (.034 amps * 4 MicroTSGs) *(0.0064 ohms/foot * cable length)
Cable length = 574 ft = 175 meters (this is cable length to MicroTSG furthest from power source).

Remote Temperature Sensor (optional)

Notes:
- See the Interface Box manual for operation of the MicroTSG with the Interface Box. The Interface Box can be added to the system at any time, and does not need to be part of the original MicroTSG order.
  - The Interface Box must be placed in a mode to communicate with the MicroTSG (**Connect45** command) before you send commands through the Interface Box to the MicroTSG.
  - The Interface Box must be placed in a mode to communicate with the SBE 38 (**Connect38** command) before you send commands through the Interface Box to the SBE 38.
- Sea-Bird software (Seasave real-time data acquisition and SBE Data Processing's Data Conversion and Derive modules) uses the data from the MicroTSG's temperature and conductivity sensors to calculate salinity, and then uses that salinity with the temperature from the remote temperature sensor to calculate density and sound velocity.

The optional 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box can append the output of an optional SBE 38 temperature sensor to the output from the MicroTSG. Often, the MicroTSG is mounted in the interior of the vessel. In this configuration the recorded conductivity is correct, but the water temperature has changed as it has passed through the plumbing system. The remote temperature sensor can be placed in a location that provides more accurate measurement of the sea surface water temperature. **The ideal location for the remote sensor is at the seawater intake (before the pump) near the bow of the ship.** This minimizes contamination of the surface temperature measurement by the ship's own thermal mass.

To compute salinity, always use the data from the temperature sensor on the MicroTSG, not from the remote temperature sensor. Conductivity has a strong thermal coefficient; therefore, it is critical to know the temperature of the water when the conductivity sensor samples it in order to compute salinity correctly. On a typical installation, there may be 20 to 30 meters of plumbing between the remote temperature sensor and the MicroTSG. As the water flows through the pipes it changes temperature dramatically, making the data from the remote temperature sensor an inaccurate representation of the temperature when the water reaches the conductivity sensor. **Use the remote temperature sensor only to report surface temperature, and to calculate density and sound velocity (density and sound velocity are a function of salinity and temperature)**.

Section 3: Installing System

This section provides information on:
- Software installation
- System schematic and installation guidelines
- Power-up mode jumper setting check
- MicroTSG installation

Installing Software

Notes:
- Help files provide detailed information on the software. Separate software manuals on the CD-ROM contain detailed information on Seasave V7 and SBE Data Processing.
- It is possible to use the MicroTSG without the Seaterm terminal program by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our website. See our website for the latest software version number, a description of the software changes, and instructions for downloading the software.

Seasoft V2 was designed to work with a PC running Win 2000/XP; extensive testing has not shown any compatibility problems when using the software with a PC running Windows Vista or Windows 7 (32-bit or 64-bit).

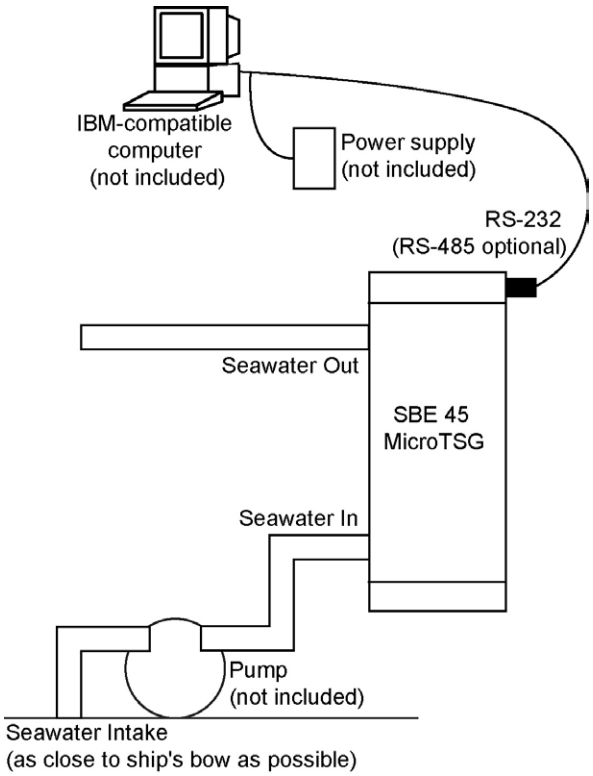
If not already installed, install Sea-Bird software programs on your computer using the supplied software CD.

1. Insert the CD in your CD drive.

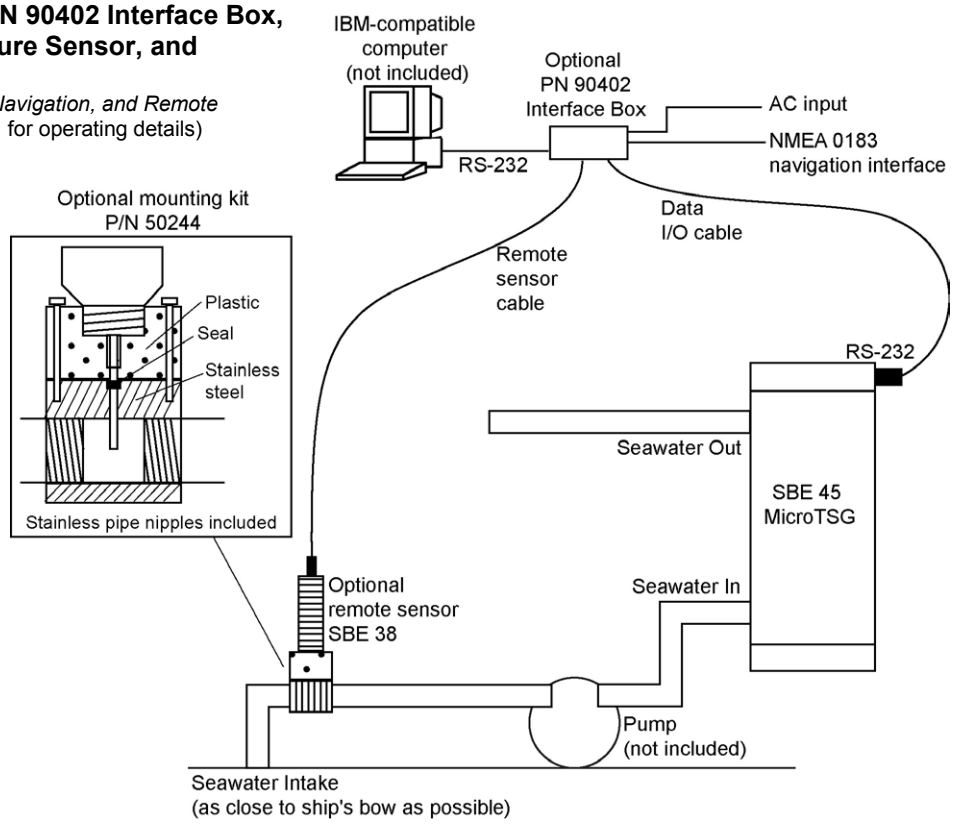
2. Install software: Double click on **SeasoftV2_*date*.exe** (*date* is the date that version of the software was created). Follow the dialog box directions to install the software. The installation program allows you to install the desired components. Install all the components, or just install Seaterm (terminal program), Seasave V7 (real-time data acquisition), and SBE Data Processing (data processing).

The default location for the software is c:\Program Files\Sea-Bird. Within that folder is a sub-directory for each component.

System Schematic and Installation Guidelines



MicroTSG with Optional PN 90402 Interface Box, SBE 38 Remote Temperature Sensor, and NMEA Navigation Device
(see *PN 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box* manual for operating details)



Sea-Bird does not provide detailed installation instructions for the MicroTSG, given the unique nature of every ship and type of installation. The installation of the MicroTSG should be done by qualified shipfitters, with the oversight of a competent ship designer or naval architect. Consider the following:

Note:
The optional Interface Box appends data from the optional SBE 38 remote temperature sensor to the MicroTSG data stream.

- The MicroTSG can be mounted anywhere it will *fit* that is accessible for maintenance and cleaning. **For safety, mount the MicroTSG above the water line.**
  - If the remote temperature sensor is not used, mount the MicroTSG as close to the seawater intake as possible to avoid thermal contamination from long plumbing runs. Thermal contamination will not affect salinity accuracy, but the MicroTSG will report the temperature of the water when it reaches the instrument.
  - If the remote temperature sensor is used, the MicroTSG can be mounted in the ship's lab or other convenient location.
- Sea-Bird does not recommend or supply a pump.
  - The pump must provide 10 to 30 milliliter/second (0.16 to 0.48 gallons/minute) flow.
  - Pressure at the MicroTSG is limited to 34.5 decibars (50 psi).
  - Research vessels often maintain seawater delivery systems for a variety of scientific purposes, including feed to a thermosalinograph. Many vessels use engine raw cooling water. However, because the MicroTSG is designed for a flow rate of 10 to 30 milliliters/second, ensure that most of the coolant flow bypasses the MicroTSG.
  - Pleasure-boat pumps designed for salt water and for below-fluid level (non-priming) may be satisfactory, although their flow rates are much too high (more than 15 gallons/minute). Some method – flow restricting orifice, bypass, etc. – is needed to reduce the flow rate to the required level. Additionally, pleasure-boat pumps are not usually certified for below-waterline use.
- Bubbles in the plumbing of a flow-through system are a common problem and will cause noisy salinity data. To minimize bubbles:
  - Place the pump below the water line to *push* rather than *lift* the water.
  - Locate the MicroTSG's hull intake as deep as possible, as far as possible from bubble sources (bow wake, propeller, etc.).
- Depending on the chosen design of a permanent seawater supply (including pump, intake fitting, pipes, etc.), a de-bubbling device may be needed to separate bubbles from the water before it enters the MicroTSG. Note that a de-bubbler may cause additional temperature errors for the MicroTSG's primary temperature sensor; salinity accuracy (and accuracy of an optional remote temperature sensor) is not affected. Not all ships require de-bubblers, but many do for best quality salinity data. Large single point salinity spikes can be removed with the Wild Edit module in SBE Data Processing.
- Route cabling as cleanly as possible, avoiding sources of noise. Electric motors are a particular problem. Avoid routing the cable next to generators and air conditioners. Cables longer than 3 meters should be installed inside an earthed metal conduit by a qualified electrician. This minimizes the potential for external signals to disrupt communication and ensures that high voltage lines (such as the sea cable) are sufficiently protected. Cables shorter than 3 meters can be used without shielding when installing or bench testing the instrument.
- If practical, mount the optional SBE 38 remote temperature sensor outside the hull. However, the SBE 38 is usually mounted in the remote sensor mount kit, which has 1-inch pipe threads on each end; plumb the mount kit into your seawater system. Install the SBE 38 as close to the seawater intake as possible (before the pump), near the bow of the ship. Since the installation is below the water line, consult your ship's engineer / naval architect / shipyard regarding the actual installation. We cannot offer advice in this matter as each ship is different and plumbing regulations vary.

Power-Up Jumper Check

The MicroTSG's Printed Circuit Board (PCB) has a jumper that controls how the MicroTSG wakes up:

- Autopower (default) – The MicroTSG wakes up when power is applied. System capability is dependent on the *external* wiring configuration:
  - Three wires – **This configuration is useful in simple systems where a controller applies power, waits for data, and then removes power**. Only three of the four wires (Power, Ground, and Transmit) are needed for operation, since it is not necessary to command the MicroTSG to take samples. Note that the MicroTSG **does not respond to any commands in this configuration**, so initial setup of the system must be performed with all four wires in place (see *Command Descriptions* in *Section 4: Setting Up MicroTSG*).
  - Four wires – With all four wires (Power, Ground, Receive, and Transmit), the MicroTSG *can* receive and respond to most commands. Note that the MicroTSG does not respond to **QS** in this configuration.

Note:
For a three-wire external wiring configuration, or to use the MicroTSG with the Interface Box, set:
- J1 jumper to Autopower
- **AutoRun=Y**, and
- **SingleSample=N**

See *Section 4: Setting Up MicroTSG*.

- Normal – The MicroTSG wakes up when there is a pulse on the serial interface lines. In this configuration, the MicroTSG can be controlled using the documented commands and can be commanded into a quiescent (sleep) state with **QS**.

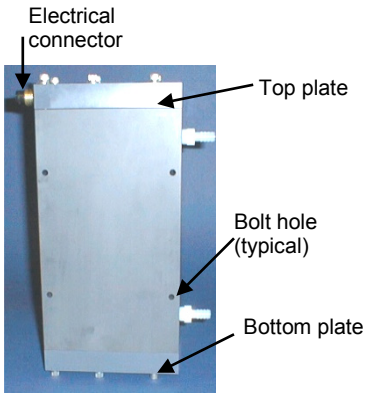
Verify the jumper setting in one of the following ways:

- Check the Configuration Sheet (in the manual) for the factory setting, or

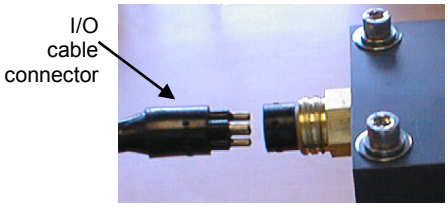
Note:
See *Appendix II: Electronics Disassembly/Reassembly* for details on accessing the PCB to change the jumper setting.

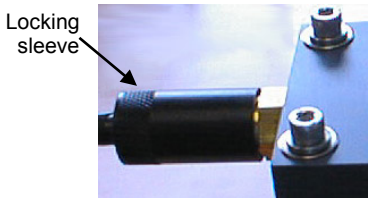
- Connect the MicroTSG to the computer as described in *Communications Test and Setup* in *Section 4: Setting Up MicroTSG*. Set the appropriate communications settings, wake up the MicroTSG with the Connect button on Seaterm's Toolbar, and then enter **QS** after the `S>` prompt.
  The response indicates whether the jumper is in the Normal or Autopower configuration:
  - Autopower – system returns `S>` prompt, indicating that the MicroTSG is **not** in quiescent (sleep) state.
  - Normal – system does not return `S>` prompt, indicating that the MicroTSG is in quiescent (sleep) state.

Installing MicroTSG



CAUTIONS:
- **Do not use WD-40** or other petroleum-based lubricants, as they will damage the connectors.
- **Silicone lubricants in a spray can** may contain ketones, esters, ethers, alcohols, or glycols in their propellant. **Do not use these sprays, as they will damage the connector.**





1. New MicroTSGs are shipped with an AF24173 Anti-Foulant Device pre-installed. Verify that the Anti-Foulant Device is in the anti-foulant device cup (see *Section 6: Routine Maintenance and Calibration* for access to and replacement of the Anti-Foulant Device).

2. Mount the MicroTSG, with the electrical connector at the top, using the four 1/4-inch bolt holes on the sides. Provide clearance as follows:
   - Bottom — 152 mm (6 inches) clearance for removal of the bottom plate, to allow access for replacing the AF24173 Anti-Foulant Device and cleaning.
   - Top — 305 mm (12 inches) clearance for removal of the top plate, to allow access for removing sensors and electronics.
   - Sides — small clearance by using washers with the mounting hardware, to prevent binding when removing the top or bottom plate.

3. Install the I/O cable:
   A. Lightly lubricate the sides of the rubber prongs on the cable connector with silicone grease (DC-4 or equivalent).
   B. Install the cable connector, aligning the long pin with the small hole on the MicroTSG's bulkhead connector.
   C. Place the locking sleeve over the connector. Tighten the sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

4. Install the piping connections to the MicroTSG. The housing is tapped with 3/8-inch U.S. standard NPT threads. Nylon hose barb fittings for 3/8-inch tubing are provided.

5. Verify that the hardware and external fittings are secure.

6. For use **without** optional Interface Box: Connect the MicroTSG to the computer and power supply (see *Dimensions and Connector* in *Section 2: Description of MicroTSG*).
   - Connect the I/O cable connector to your computer's serial port.
   - Connect the I/O cable connector's red (+) and black (-) wires to a power supply (8-30 VDC).

7. For use **with** optional Interface Box: See schematic in *System Schematic and Installation Guidelines* above, and see *PN 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box* manual.

Section 4: Setting Up MicroTSG

Note:
See the Interface Box manual for operation of the MicroTSG with the Interface Box. The Interface Box can be added to the system at any time, and does not need to be part of the original MicroTSG order.

- **The Interface Box must be placed in a mode to communicate with the MicroTSG (Connect45 command) before you send commands through the Interface Box to the MicroTSG.**

This section provides information on:

- MicroTSG setup
- Sampling modes and example sets of operation commands
- Timeout description
- Command descriptions
- Data output format
- Setting up configuration (.xmlcon or .con) file for real-time data acquisition and data processing

Communications Test and Setup

Note:
See Seaterm's Help files.

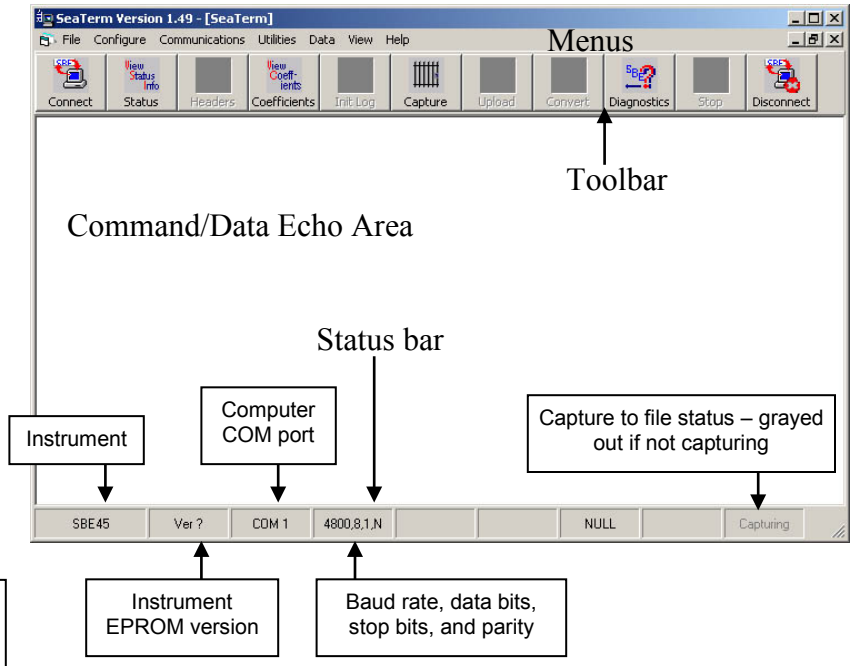
The power and communications test will verify that the system works, prior to deployment.

1. Double click on Seaterm.exe. If this is the first time the program is used, the configuration dialog box may appear:

SeaTerm Setup
The initialization file: SeaTerm.ini was not found in the Windows directory. Please enter the following setup information.
**IMPORTANT: To complete setup, review the configuration setting for your instrument by selecting your instrument type from the Configure menu list.
Instrument Type
SBE45
COM Port
1
OK

Select the instrument type (SBE 45) and the computer COM port for communication with the MicroTSG. Click OK.

2. The main screen looks like this:


SeaTerm Version 1.49 - [SeaTerm]
File Configure Communications Utilities Data View Help
Connect Status Headers Coefficients Init Log Capture Upload Convert Diagnostics Stop Disconnect
Menus
Toolbar
Command/Data Echo Area
Status bar
Instrument
Computer COM port
Capture to file status – grayed out if not capturing
SBE45 Ver ? COM 1 4800,8,1,N NULL Capturing
Instrument EPROM version
Baud rate, data bits, stop bits, and parity

Note:
There is at least one way, and as many as three ways, to enter a command:
- Manually type a command in Command/Data Echo Area
- Use a menu to automatically generate a command
- Use a Toolbar button to automatically generate a command

Note:
Once the system is configured and connected (Steps 3 through 5), to update the Status bar:
- on the Toolbar, click Status; or
- from the Utilities menu, select Instrument Status.

Seaterm sends the status command, which displays in the Command/Data Echo Area, and updates the Status bar.

- Menus – Contains tasks and frequently executed instrument commands.
- Toolbar – Contains buttons for frequently executed tasks and instrument commands. All tasks and commands accessed through the Toolbar are also available in the Menus. To display or hide the Toolbar, select View Toolbar in the View menu. Grayed out Toolbar buttons are not applicable.
- Command/Data Echo Area – Echoes a command executed using a Menu or Toolbar button, as well as the instrument's response. Additionally, a command can be manually typed in this area, from the available commands for the instrument. Note that the instrument must be 'awake' for it to respond to a command (use Connect on the Toolbar to wake up the instrument).
- Status bar – Provides status information. To display or hide the Status bar, select View Status bar in the View menu.

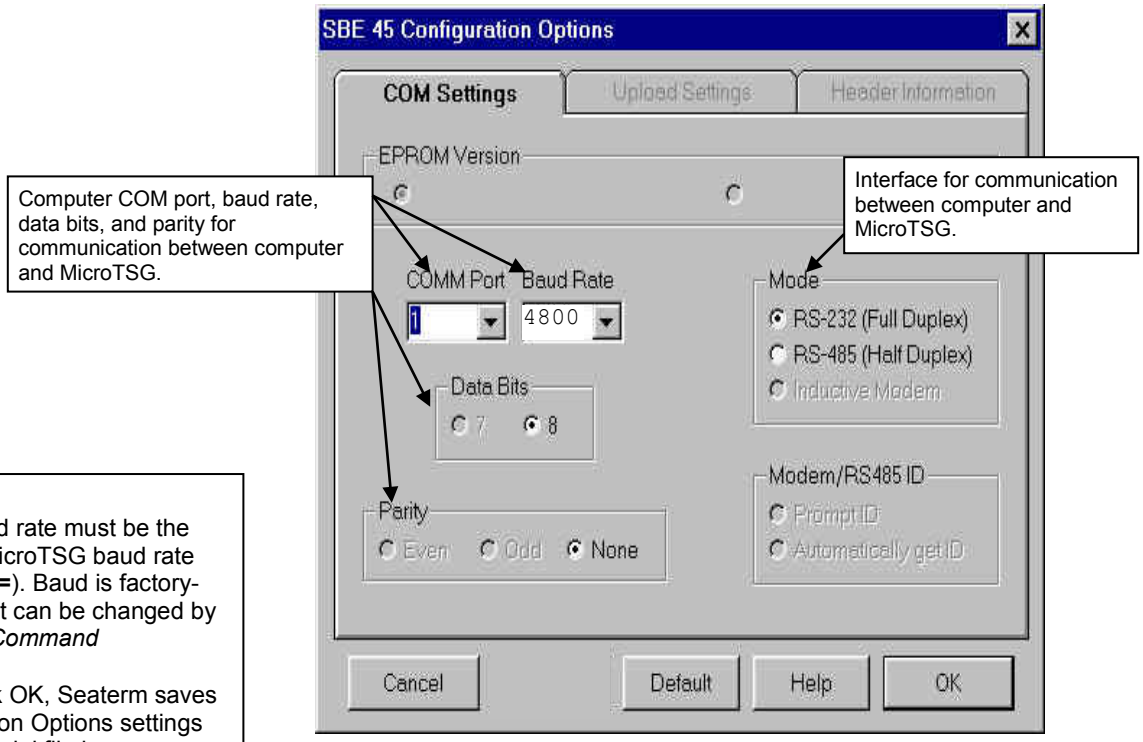
Following are the Toolbar buttons applicable to the MicroTSG:

Toolbar Buttons	Description	Equivalent Command*
Connect	Re-establish communications with MicroTSG. Computer responds with S> prompt.	(press Enter key)
Status	Display instrument status.	**DS**
Coefficients	Display calibration coefficients.	**DC**
Capture	Capture instrument responses on screen to file. File has .cap extension. Click Capture again to turn off capture. Capture status displays in Status bar. As MicroTSG has no internal memory, you must capture before sampling begins to save data for future review and processing.	—
Diagnostics	Perform one or more diagnostic tests on MicroTSG. Diagnostic test(s) accessed in this manner are non-destructive – they do not write over any existing instrument settings.	**DS, DC, TS,** and **TSR**
Disconnect	Free computer COM port used to communicate with MicroTSG. COM port can then be used by another program. Note that MicroTSG must be connected to COM port for data to be obtained.	—

*See *Command Descriptions*.

Note:
.cap file created by Seaterm is not compatible with our post-processing software (SBE Data Processing). Instead of using Seaterm's capture utility, use Seasave (our real-time data acquisition software) to create a .hex file that is compatible with SBE Data Processing (see *Section 5: Operating System*).

3. In the Configure menu, select SBE 45 TSG. The dialog box looks like this:



Note:
- Seaterm's baud rate must be the same as the MicroTSG baud rate (set with **Baud=**). Baud is factory-set to 4800, but can be changed by the user (see *Command Descriptions*).
- When you click OK, Seaterm saves the Configuration Options settings to the SeaTerm.ini file in your Windows directory. SeaTerm.ini contains the last saved settings for **each** instrument. When you open Seaterm and select the desired instrument (SBE 37, 45, etc.) in the Configure menu, the Configuration Options dialog box shows the last saved settings for that instrument.

Make the selections in the Configuration Options dialog box:
- **COMM Port**: COM 1 through COM 10, as applicable
- **Baud Rate**: 4800 (documented on Configuration Sheet in manual)
- **Data Bits**: 8
- **Parity**: None
- **Mode**: RS-232 (Full Duplex)

Click OK to save the settings.

4. In the Communications menu, select *Options / Cycle baud when connecting*.

5. Click Connect on the Toolbar. Seaterm tries to connect to the MicroTSG at the baud set in Step 3. If it cannot, it cycles through all other possible baud rates to try to connect. When it connects, the display looks like this:

   ```
   S>SBE45 V 1.1b
   S>
   ```

   This shows that correct communications between the computer and MicroTSG has been established. If the system does not respond as shown:
   - Click Connect again.
   - Verify the correct instrument was selected in the Configure menu and the settings were entered correctly in the Configuration Options dialog box.
   - Check cabling between the computer and MicroTSG.

6. Display MicroTSG status information by clicking Status on the Toolbar. The display looks like this:

   ```
   SBE45 V 1.1b  SERIAL NO. 1258
   not logging data
   sample interval = 30 seconds
   output conductivity with each sample
   do not output salinity with each sample
   do not output sound velocity with each sample
   do not start sampling when power on
   do not power off after taking a single sample
   do not power off after two minutes of inactivity
   A/D cycles to average = 4
   ```

7. Command the MicroTSG to take a sample by typing **TS** and pressing the Enter key. The display looks like this (if *output conductivity with each sample*, *do not output salinity with each sample*, and *do not output sound velocity with each sample* displayed in response to the status command in Step 6) :

   ```
   23.7658, 0.00019
   ```

   where 23.7658 = temperature in degrees Celsius
   0.00019 = conductivity in S/m
   These numbers should be reasonable; i.e., room temperature and zero conductivity.

8. Establish the sampling scheme, after reviewing the information in this section on sampling modes and commands.

9. Command the MicroTSG to go to sleep (quiescent state) by typing **QS** and pressing the Enter key. The response indicates whether the PCB's J1 jumper is in the Normal or Autopower configuration:
   - Autopower – system returns `S>` prompt.
   - Normal – system does not return `S>` prompt.

   If necessary, remove the PCB and move the jumper to the desired pins.

Notes:
- See *Power-Up Jumper Check* in *Section 3: Installing System* for a description of Autopower and Normal.
- See *Appendix II: Electronics Disassembly/Reassembly* to access the PCB and move the jumper.

The MicroTSG is ready for deployment.

Sampling Modes

The MicroTSG has three basic sampling modes for obtaining data: Polled Sampling, Autonomous Sampling, and Serial Line Synchronization Sampling. However, commands and the J1 jumper setting on the MicroTSG's PCB can be used in various combinations to provide a high degree of operating flexibility.

Shown below are descriptions and examples of the three basic sampling modes. Note that the MicroTSG's response to each command is not shown in the examples. Review the operation of the basic sampling modes and the commands described in *Command Descriptions* before setting up your system.

Note:
After waking the MicroTSG, you may need to press the Enter key several times and send **Stop** to interrupt sampling, depending on how the instrument was set up the last time it was used.

Polled Sampling

On command, the MicroTSG takes one sample of data and sends the data to the computer.

Examples: ***Polled Sampling Mode*** (user input in bold)

Example 1*:* J1 jumper in Normal position (pins 2 and 3).
Wake up MicroTSG. Set up to wait for command each time MicroTSG wakes up, and send salinity with data. Send status command to verify setup. Send power-off command after all parameters are entered. Assuming that power is always applied:

(Click Connect on Toolbar to wake up.)
S>**AUTORUN=N**
S>**OUTPUTSAL=Y**
S>**DS** (to verify setup)
S>**QS**

When ready to take a sample (repeat as desired): wake up MicroTSG, command it to take a sample and output converted data to computer, and send power-off command.

(Before first sample, click Capture on Toolbar to capture data to a file – program requests file name for data to be stored.)
(Click Connect on Toolbar to wake up.)
S>**TS**
S>**QS**

Example 2*:* J1 jumper in Autopower position (pins 1 and 2).
Wake up MicroTSG. Set up to wait for command each time MicroTSG wakes up, and send salinity with data. Send status command to verify setup. Remove power after all parameters are entered.

(Apply power to wake up.)
S>**AUTORUN=N**
S>**OUTPUTSAL=Y**
S>**DS** (to verify setup)
(Remove power.)

When ready to take a sample (repeat as desired): wake up MicroTSG, command it to take a sample and output converted data to computer, and remove power.

(Before first sample, click Capture on Toolbar to capture data to a file – program requests file name for data to be stored.)
(Apply power to wake up.)
S>**TS**
(Remove power.)

Notes:
- After waking the MicroTSG, you may need to press the Enter key several times and send **Stop** to interrupt sampling, depending on how the instrument was set up the last time it was used.
- If using the MicroTSG with the Interface Box, set up the MicroTSG to operate in autonomous sampling mode:
  - J1 jumper in Autopower position (pins 1 and 2)
  - **AutoRun=Y**
  - **SingleSample=N**

Autonomous Sampling

The MicroTSG samples data at pre-programmed intervals, defined by **Interval=**, and sends the data to the computer. The MicroTSG does not enter quiescent (sleep) state between samples.

Examples: ***Autonomous Sampling Mode*** (user input in bold)

Example 1*:* J1 jumper in Normal position (pins 2 and 3)**, AutoRun=Y.**
Set up to take a sample every 20 seconds. Send status command to verify setup. Send power-off command after all parameters are entered. Assuming that power is always applied:

(Click Connect on Toolbar to wake up.)
S>**SINGLESAMPLE=N**
S>**INTERVAL=20**
S>**AUTORUN=Y**
S>**DS** (to verify setup)
S>**QS**

When ready to begin sampling:

(Click Capture on Toolbar to capture data to a file – program requests file name for data to be stored.)
(Click Connect on Toolbar to wake up – sampling begins automatically.)

When ready to stop sampling and go to sleep:

(Press Enter key to get S> prompt.)
S>**STOP**
S>**QS**

Example 2*:* J1 jumper in Normal position (pins 2 and 3)**, AutoRun=N.**
Set up to take a sample every 20 seconds. Send status command to verify setup. Send power-off command after all parameters are entered. Assuming that power is always applied:

(Click Connect on Toolbar to wake up.)
S>**SINGLESAMPLE=N**
S>**INTERVAL=20**
S>**AUTORUN=N**
S>**DS** (to verify setup)
S>**QS**

When ready to begin sampling:

(Click Capture on Toolbar to capture data to a file – program requests file name for data to be stored.)
(Click Connect on Toolbar to wake up.)
S>**GO**

When ready to stop sampling and go to sleep:

(Press Enter key to get S> prompt.)
S>**STOP**
S>**QS**

Example 3*:* J1 jumper in Autopower position (pins 1 and 2).
Set up to take a sample every 20 seconds. Send status command to verify setup. Remove power after all parameters are entered.

(Apply power to wake up.)
S>**SINGLESAMPLE=N**
S>**INTERVAL=20**
S>**AUTORUN=Y**
S>**DS** (to verify setup)
(Remove power.)

When ready to begin sampling:

(Click Capture on Toolbar to capture data to a file – program requests file name for data to be stored)
(Apply power to wake up; sampling begins automatically.)

When ready to stop sampling:

(Remove power.)

To change the setup:

(Apply power to wake up; sampling begins automatically. Press Enter key several times to get S> prompt.)
S>**STOP**
S> (send desired commands)
(Remove power.)

Serial Line Synchronization (Serial Line Sync)

Note:
After waking the MicroTSG, you may need to press the Enter key several times and send **Stop** to interrupt sampling, depending on how the instrument was set up the last time it was used.

In Serial Line Sync Mode, a simple pulse (a single character) on the RS-232 line causes the MicroTSG to wake up, take and output a single sample, and automatically go to sleep (enter quiescent state). This mode is enabled if **AutoRun=Y**, **SingleSample=Y**, and the PCB's J1 jumper is in the Normal position (pins 2 and 3).

Example: ***Serial Line Sync Mode*** (user input in bold)
(J1 jumper in Normal position – pins 2 and 3)

Set up to take a sample upon receipt of any character and then automatically go to sleep. Send status command to verify setup. Send power-off command to MicroTSG after all parameters are entered – system automatically wakes up and goes to sleep for each sample upon receipt of a character. Assuming that power is always applied:

(Click Connect on Toolbar to wake up.)
S>**SINGLESAMPLE=Y**
S>**AUTORUN=Y**
S>**DS** (to verify setup)
S>**QS**

When ready to take a sample (repeat as desired):

(Before first sample, click Capture on Toolbar to capture data to a file – program requests file name for data to be stored)
(Press Enter key to wake up, sample, and go to sleep.)

When ready to stop sampling or change setup:

(Press Enter key several times to get S> prompt)
S>**STOP**
S> (Enter desired commands)
S>**QS**

Timeout Description

The MicroTSG has a timeout algorithm when jumpered in the Normal configuration (PCB J1 pins 2 and 3). If the MicroTSG does not receive a command or sample data for two minutes and **AutoOff=Y**, it powers down its communication circuits. This places the MicroTSG in quiescent state, drawing minimal current. **To re-establish control (wake up), click Connect on the Toolbar or press the Enter key.** The system responds with the S> prompt.

Command Descriptions

Note:
See the Interface Box manual for operation of the MicroTSG with the Interface Box. The Interface Box can be added to the system at any time, and does not need to be part of the original MicroTSG order.

- **The Interface Box must be placed in a mode to communicate with the MicroTSG (Connect45 command) before you send commands through the Interface Box to the MicroTSG.**

This section describes commands and provides sample outputs.
See *Appendix III: Command Summary* for a summarized command list.

When entering commands:

- Input commands to the MicroTSG in upper or lower case letters and register commands by pressing the Enter key.
- The MicroTSG sends `? CMD` if an invalid command is entered.
- If the system does not return an `S>` prompt after executing a command, press the Enter key to get the `S>` prompt.
- If in quiescent state, re-establish communications by clicking Connect on the Toolbar or pressing the Enter key to get an `S>` prompt.

Status Command

DS

Display operating status and setup parameters. Equivalent to Status on Toolbar.

List below includes, where applicable, command used to modify parameter.

- Firmware version and serial number
- Logging status - `logging data, not logging data,` or `unknown status`
- Sample interval time [**Interval=**]
- Output conductivity with each sample [**OutputCond=**]?
- Output salinity with each sample [**OutputSal=**]?
- Output sound velocity with each sample [**OutputSV=**]? If yes, sound velocity algorithm [**SVAlgorithm=**].
- Start sampling automatically when power on [**AutoRun=**]?
- Go to sleep after taking single sample [**SingleSample=**]?
- Go to sleep after 2 minutes of inactivity [**AutoOff=**]?
- A/D cycles to average per sample [**NCycles=**]
- Output format (does not appear if **OutputFormat=0**. Shows *conductivity leading space is suppressed* if **OutputFormat=1**; shows *conductivity and salinity order reversed* if **OutputFormat=2**)

Example: (user input in bold)

```
S>DS
SBE45 V 1.1b  SERIAL NO. 1258
not logging data
sample interval = 10 seconds                                    [Interval=]
output conductivity with each sample                            [OutputCond=]
do not output salinity with each sample                         [OutputSal=]
do not output sound velocity with each sample                   [OutputSV= and SVAlgorithm=]
do not start sampling when power on                             [AutoRun=]
do not power off after taking a single sample                   [SingleSample=]
do not power off after two minutes of inactivity                [AutoOff=]
A/D cycles to average = 4                                       [NCycles=]
```

Setup Commands

Notes:
- The MicroTSG's baud rate (set with **Baud=**) must be the same as Seaterm's baud rate (set in the Configure menu).
- The maximum baud rate is dependent on cable length. See *Baud Rate, Cable Length, Power, and Data Transmission Rate* in *Section 2: Description of MicroTSG*.

Baud=x

x= baud rate (1200, 2400, 4800, 9600, 19200, or 38400). Default 4800.

Notes:
- See *Data Output Format*.
- Seasave, SBE Data Processing, and the optional Interface Box are all compatible with any combination of output parameters, if **OutputFormat=0** or **1**.

OutputFormat=x

x=0 (default): Output order is temperature, conductivity, salinity, sound velocity.

x=1: Suppress space before conductivity output.

x=2: Reverse conductivity and salinity order. This is not compatible with Seasave, SBE Data Processing, or optional Interface Box.

OutputCond=x

x=Y (default): calculate and output conductivity (S/m).

x=N: do not.

OutputSal=x

x=Y: calculate and output salinity (psu).

x=N (default): do not.

OutputSV=x

x=Y: calculate and output sound velocity (m/sec). Can be calculated as Chen and Millero or as Wilson; select desired algorithm with **SVAlgorithm=**.

x=N (default): do not.

SVAlgorithm=x

x=C: If **OutputSV=Y**, calculate sound velocity using Chen and Millero formula (UNESCO Technical Papers in Marine Science #44). Default.

x=W: If **OutputSV=Y**, calculate sound velocity using Wilson formula (UNESCO Technical Papers in Marine Science #44).

NCycles=x

x= number of measurements to average per sample (default = 4). Increasing **NCycles=** increases measurement resolution and time required for measurement. See *Sample Timing* in *Section 2: Description of MicroTSG*.

QS

Quit session and place MicroTSG in quiescent (sleep) state. Sampling stops. Applicable only if PCB J1 jumper is in Normal position.

Operating Commands

Operating commands configure the MicroTSG's response upon waking up, and direct the MicroTSG to sample data once or at pre-programmed intervals.

Note:
If the total time required for the sample is greater than **Interval=**, the MicroTSG begins the next sample as soon as it finishes transmitting the current sample.

Interval=x

x= interval (seconds) between samples (maximum 32767 seconds). MicroTSG samples at this interval, and does not enter quiescent (sleep) state between samples. Minimum time between samples determined by **NCycles=**, desired calculated parameters (salinity, etc.), and baud rate; see *Sample Timing* and *Baud Rate, Cable Length, Power, and Data Transmission Rate* in *Section 2: Description of MicroTSG*.

AutoOff=x

(Functional only if J1 jumper on PCB is in Normal position)
x=Y: Go to sleep (enter quiescent state) if 2 minutes have elapsed without receiving a command or without sampling data.

x= N: Do not automatically go to sleep.

AutoRun=x

x=Y or **N**: Interacts with **SingleSample=** and J1 jumper setting, as described in table below.

SingleSample=x

x=Y or **N**: Interacts with **AutoRun=** and J1 jumper setting, as described in table below.

Note:
If the MicroTSG is sampling data and the external voltage is less than 6.15 volts for ten consecutive scans, the MicroTSG halts logging.

Go

Start sampling, as defined by **SingleSample=** and **Interval=**.
Only applicable if:
- **AutoRun=N**, or
- **AutoRun=Y** and you previously sent **Stop** to stop sampling.

Note:
You may need to send **Stop** several times to get the MicroTSG to respond. This is most likely to occur if sampling with a small **Interval=**.

Stop

Stop sampling. Press Enter key to get `S>` prompt before entering **Stop**.

J1 Jumper	AutoRun	SingleSample	Effect
Normal (pins 2 and 3)	**N**	**Y** or **N**	Wake up (when Connect on Toolbar clicked or Enter key pressed while asleep) state and wait for command.
	Y	**N**	Wake up (when Connect on Toolbar clicked or Enter key pressed while asleep) and sample at rate specified by **Interval=**. To stop sampling and get `S>` prompt, type **Stop** and press Enter key.
	Y	**Y**	Wake up (when Connect on Toolbar clicked or Enter key pressed while asleep), take and output single sample, and automatically go to sleep. To wake up and get `S>` prompt, type **Stop** and press Enter key. Referred to as **Serial Line Sync Mode**.
Autopower (pins 1 and 2)	**N**	**Y** or **N**	Wake up when power applied and wait for command.
	Y	**N**	Wake up when power applied and sample at rate specified by **Interval=** until power removed. **Required settings for MicroTSG in 3-wire (power, ground, and transmit) configuration or when using MicroTSG with Interface Box.**
	Y	**Y**	Wake up when power applied and take and output a single sample. Wait for another command until power removed.

Polled Sampling Commands

These commands are used by an external controller to request a sample from the MicroTSG. The MicroTSG stores data for the most recent sample in its RAM. The MicroTSG does not automatically go to sleep after executing these commands. Do not send these commands if the MicroTSG is sampling data at pre-programmed intervals (defined by **Interval=** and **SingleSample=**).

TS	Take sample, hold converted data in RAM, output converted data.
TSR	Take sample, hold raw data (temperature and conductivity only) in RAM, output raw data.
SLT	Send last sample from RAM, output converted data, then take new sample and hold converted data in RAM.
TH	Take sample, hold converted data in RAM.
SH	Send held converted data from RAM.

Testing Commands

TT	Measure temperature 100 times or until Esc key is pressed, output converted data.
TC	Measure conductivity 100 times or until Esc key is pressed, output converted data.
TTR	Measure temperature 100 times or until Esc key is pressed, output raw data.
TCR	Measure conductivity 100 times or until Esc key is pressed, output raw data.

Calibration Coefficients Commands

DC Display calibration coefficients.
Equivalent to Coefficients on Toolbar.

Notes:
- See individual Coefficient Commands below for definitions of the data in the example.
- Dates shown are when calibrations were performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with MicroTSGs.

Example: (user input in bold)

```
S>DC
SBE45   V 1.1b   0011
temperature: 08-apr-96
TA0 =  -9.420702e-05
TA1 =   2.937924e-04
TA2 =  -3.739471e-06
TA3 =   1.909551e-07
conductivity: 09-apr-96
G =           -1.036689e+00
H =            1.444342e-01
I =           -3.112137e-04
J =            3.005941e-05
CPCOR =       -9.570001e-08
CTCOR =        3.250000e-06
WBOTC =        1.968100e-05
```

The individual Coefficient Commands listed below are used to modify a particular coefficient or date:

Note:
F = floating point number
S = string with no spaces

Temperature

TCalDate=S **S**=Temperature calibration date.
TA0=F **F**=Temperature A0.
TA1=F **F**=Temperature A1.
TA2=F **F**=Temperature A2.
TA3=F **F**=Temperature A3.

Conductivity

CCalDate=S **S**=Conductivity calibration date.
CG=F **F**=Conductivity G.
CH=F **F**=Conductivity H.
CI=F **F**=Conductivity I.
CJ=F **F**=Conductivity J.
WBOTC=F **F**=Conductivity wbotc.
CTCor=F **F**=Conductivity ctcor.
CPCor=F **F**=Conductivity cpcor.

Data Output Format

Each scan ends with a carriage return <CR> and line feed <LF>. Leading zeros are suppressed, except for one zero to the left of the decimal point. All data is separated with a comma and a space, except as noted.

Notes:
- For **OutputFormat=1**, the space before the conductivity output is eliminated. The remainder of the data format is unchanged from **OutputFormat=0**.
- Seasave, SBE Data Processing, and the optional Interface Box are all compatible with any combination of output parameters, if **OutputFormat=0** or **1**.

The converted output data format is:
- If **OutputFormat=0** (default):
  `ttt.tttt, cc.ccccc, sss.ssss, vvvv.vvv`
- If **OutputFormat=1**:
  `ttt.tttt,cc.ccccc, sss.ssss, vvvv.vvv`
- If **OutputFormat=2**:
  `ttt.tttt, sss.ssss, cc.ccccc, vvvv.vvv`
  Note: **OutputFormat=2** is **not compatible** with Seasave, SBE Data Processing, or the optional Interface Box.

where
t = temperature (degrees Celsius, ITS-90)
c = conductivity (S/m); data sent only if **OutputCond=Y**
s = salinity (psu); data sent only if **OutputSal=Y**
v = sound velocity (meters/second), calculated by Chen-Millero (if **SVAlgorithm=C**) or Wilson (if **SVAlgorithm=W**) equation; data sent only if **OutputSV=Y**

Example 1: Sample data output when **OutputFormat=0**, **OutputCond=Y**, **OutputSal=N**, and **OutputSV=N**:
`23.7658, 0.00019`
(temperature, conductivity)

Example 2: Sample data output when **OutputFormat=1**, **OutputCond=Y**, **OutputSal=N**, and **OutputSV=N**:
`23.7658,0.00019`
(temperature,conductivity)

Setting Up Configuration (.xmlcon or .con) File

Notes:
- Seasave and SBE Data Processing versions 7.20a introduced .xmlcon files (in XML format). Versions 7.20a and later allow you to open a .con or .xmlcon file, and to save t to a .con or .xmlcon file. Seasave and SBE Data Processing use the same file.
- A new or recalibrated instrument ships with a configuration file that reflects the current configuration *as we know it*. The file is named with the instrument serial number, followed by a .con extension. For example, for an instrument with serial number 2375, Sea-Bird names the file *2375.con*. You may rename the file (but not the extension) if desired; this will not affect the results.

Seasave and SBE Data Processing, our real-time data acquisition and data processing software (respectively), require a configuration file. The configuration file defines the MicroTSG – which parameters are output by the MicroTSG, and the data output rate - and indicates whether NMEA and SBE 38 data is to be appended to the data stream. The software uses the configuration file to interpret and process the data. **If the configuration file does not match the actual instrument configuration, the software will not be able to interpret and process the data correctly.**

To verify the contents of the .xmlcon or .con file:

1. Double click on Seasave.exe.

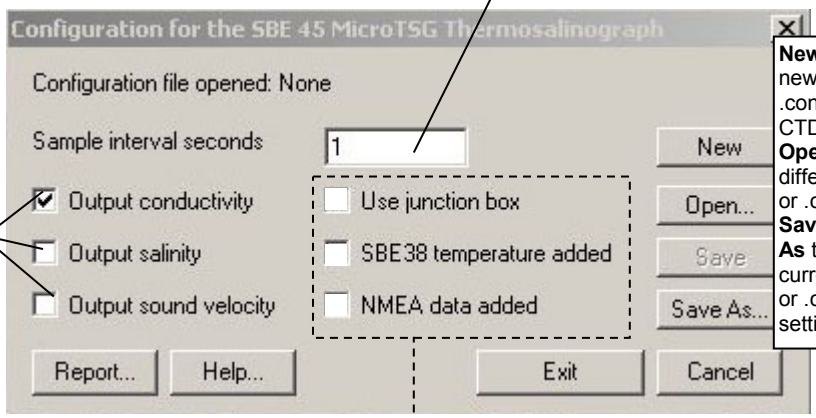
2. Click Configure Inputs. On the Instrument Configuration tab, click *Open*. In the dialog box, select the .xmlcon or .con file and click Open.

3. The configuration information appears on the Instrument Configuration tab. Verify the output matches the output programmed into the SBE 45, and the use of the optional Interface Box, SBE 38, and NMEA matches your system. Click Modify to bring up a dialog box (shown below) to change the configuration.

Time between scans. Must agree with MicroTSG setup (**Interval=**); see reply from **DS**.

Define data in MicroTSG data stream:
- *Output conductivity* with each scan - Must agree with MicroTSG setup (**OutputCond=**).
- *Output salinity* with each scan – Must agree with MicroTSG setup (**OutputSal=**).
- *Output sound velocity* with each scan – Must agree with MicroTSG setup (**OutputSV=**).

See reply from **DS** for setup programmed into MicroTSG.



New to create new .xmlcon or .con file for this CTD.
Open to select different .xmlcon or .con file.
Save or **Save As** to save current .xmlcon or .con file settings.

- *Use junction box* – Select if MicroTSG data transmitted to computer through Interface Box.
- *SBE 38 temperature added* – only applicable if *Use junction box* is selected. Select if Interface Box connected to SBE 38 remote temperature sensor. If selected, Seasave and SBE Data Processing (Data Conversion and Derive modules) use remote temperature data when calculating density and sound velocity.
- *NMEA data added* – only applicable if *Use junction box* is selected. Select if Interface Box connected to a NMEA navigation device. Seasave automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in Seasave's Configure menu to control how Lat/Lon data is incorporated.

See *PN 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box* manual.

4. Click *Save* or *Save As* to save any changes to the .xmlcon or .con file. Click Exit when done reviewing /modifying the configuration.

Section 5: Operating System

Note:
For acquiring data in Seasave, the MicroTSG must be set up for autonomous sampling (**SingleSample=N**).

This section covers acquiring real-time data with Seasave, and processing data with SBE Data Processing.

- Seasave saves the data in the format – data format and header information – that is required by SBE Data Processing. If you use other software to acquire data, the data will not be in the format required by SBE Data Processing.

If using the MicroTSG with PN 90402 - SBE 45 Power, Navigation, and Remote Temperature Interface Box, see the Interface Box manual for operating the system.

Acquiring Real-Time Data with Seasave

Note:
See Seasave's manual and/or help files.

1. Turn on power to the MicroTSG.
   - If the MicroTSG is set to **AutoRun=Y** and the J1 jumper is in the Autopower position (start sampling automatically when power is turned on): MicroTSG will start sampling and transmitting data to the computer. Note that the data will not appear in Seasave until you tell Seasave to start real-time data acquisition in Step 7.
   - If the MicroTSG is set to **AutoRun=N** or the J1 jumper is in the Normal position: Run Seaterm, click Seaterm's Connect button, command the MicroTSG to start sampling (**Go**), click Seaterm's Disconnect button, and then close Seaterm.

   See *Section 4: Setting Up MicroTSG*.

2. Double click on Seasave.exe.

Note:
The baud rate between the MicroTSG and computer (defined in Configure Inputs, on the Serial Ports tab) must agree with the baud rate programmed into the MicroTSG with **Baud=**.

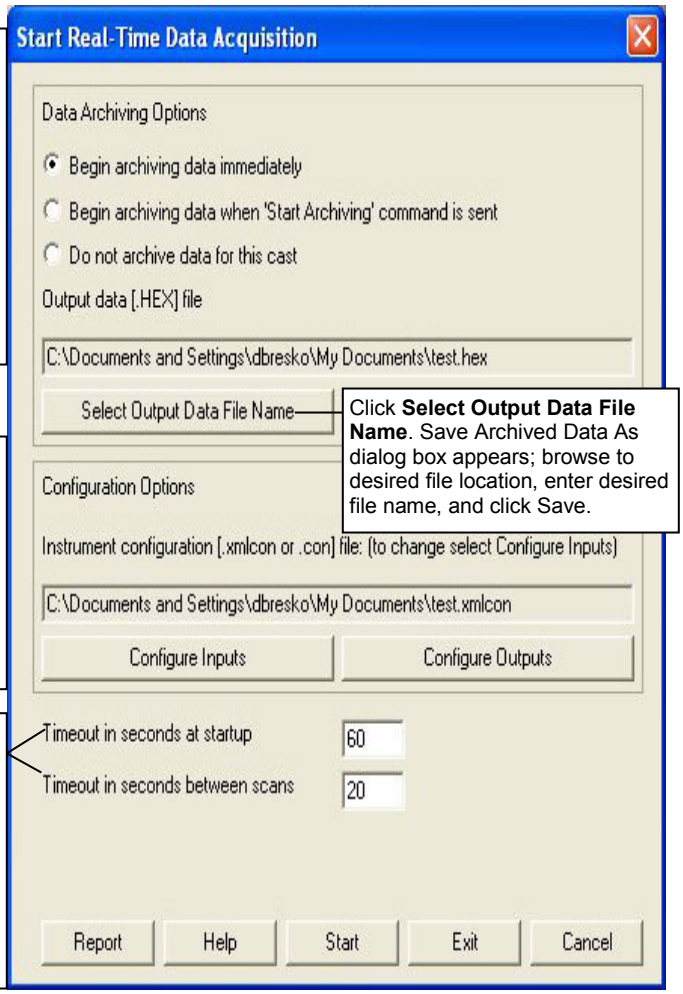
3. Perform any desired setup in the Configure Inputs, Configure Outputs, and Display menus.

4. In the RealTime Data menu, select *Start Acquisition*. The dialog box looks like this:

Data Archiving Options:
- **Begin archiving data immediately** to store raw (frequencies, A/D counts, and/or voltages) real-time data as soon as Start button is clicked and communication is established.
- **Begin archiving data when 'Start Archiving' command is sent** to control when data begins to be written to file. If you make this selection, when you click Start button and communication is established, a dialog box with Start Archiving button appears. Click this button when ready to begin saving scans to file, or select Start Archiving in Real-Time Data menu.
- **Do not archive data for this cast** to not save data to a file. Real-time data will still appear in displays.

Configuration Options: Currently selected instrument configuration (.xmlcon or .con) file is shown, containing information on output from MicroTSG, use of Interface Box, and inclusion of NMEA and SBE 38 data with output from MicroTSG. To modify input configuration (xmlcon or .con file, serial ports, TCP/IP ports, and/or miscellaneous), click Configure Inputs. To modify outputs (serial data output, serial ports shared file output, mark variables, TCP/IP output, TCP/IP ports, SBE 14 remote display, header form, and/or diagnostics), click Configure Outputs.

- **Timeout in seconds at startup**: Time allowed before first data scan is received from MicroTSG. Seasave will *time out* and stop attempting to acquire data if data is not received from MicroTSG within this time period.
- **Timeout in seconds between scans**: Maximum **gap** allowed between scans after first data scan is received from MicroTSG. Seasave will *time out* and stop attempting to acquire data if data is not received from MicroTSG within this time period (for example, if a problem with power interrupts data acquisition, Seasave stops attempting to acquire data after this gap).



Click **Select Output Data File Name**. Save Archived Data As dialog box appears; browse to desired file location, enter desired file name, and click Save.

5. In the Start Real-Time Data Acquisition dialog box, click *Start*.
   A. If you selected *Begin archiving data immediately* or *Begin archiving data when 'Start Archiving' command is sent* above, and selected *Prompt for Header Information* in the Header Form setup (Configure Outputs), the Header Information dialog box appears. Fill in the desired header and click OK.
   B. If you selected *Check Scan Length* in the Options menu, Seasave checks the configuration (.xmlcon or .con) file to verify that the scan length defined by the configuration file matches the MicroTSG (i.e., number of sensors and inclusion of NMEA is as defined in the file). If a *Scan length error* appears, verify that:
      - You are using the correct .xmlcon or .con configuration file.
      - The configuration file has been updated as necessary if you added or deleted outputs, added or deleted Interface Box, etc.
   C. Seasave sends a message: *Waiting for data . . .* Seasave will *time out* if data is not received within *Timeout in seconds at startup*.
   D. Real-time data then starts appearing in the screen display(s).

6. To stop real-time data acquisition: In the Real-Time Data menu, select *Stop*.

7. Stop the MicroTSG sampling by turning off power.

Processing Data

Process the data in SBE Data Processing.

Note:
See the SBE Data Processing manual and/or Help files.

1. Convert the .hex data file created by Seasave to a .cnv file in SBE Data Processing's Data Conversion module.

2. Once the data is converted, it can be further processed and plotted in SBE Data Processing's other modules.

Editing .hex Data File

Sometimes users want to edit the .hex data file before beginning processing, to remove data at the beginning of the file corresponding to instrument *soak* time, to remove blocks of bad data, to edit the header, or to add explanatory notes. **Editing the .hex file can corrupt the data, making it impossible to perform further processing using Sea-Bird software.** We strongly recommend that you first convert the data to a .cnv file (using Data Conversion in SBE Data Processing), and then use other SBE Data Processing modules to edit the .cnv file as desired.

Note:
Although we provide this technique for editing a .hex file, **Sea-Bird's strong recommendation, as described above, is to always convert the .hex data file and then edit the converted (.cnv) file.**

The procedure for editing a .hex data file described below has been found to work correctly on computers running Windows 98, 2000, and NT. **If the editing is not performed using this technique, SBE Data Processing may reject the edited data file and give you an error message.**

1. **Make a back-up copy of your .hex data file before you begin.**
2. Run **WordPad**.
3. In the File menu, select Open. In the Open dialog box: for *Files of type*, select *All Documents (*.*)*. Browse to the desired .hex file and click Open.
4. Edit the file as desired, **inserting any new header lines after the System Upload Time line**. Note that all header lines must begin with an asterisk (*), and *END* indicates the end of the header. An example is shown below (for an SBE 21 data file), with the added lines in bold:

```
* Sea-Bird SBE 21 Data File:
* FileName = C:\Odis\SAT2-ODIS\oct14-19\oc15_99.hex
* Software Version Seasave Win32 v1.10
* Temperature SN = 2366
* Conductivity SN = 2366
* System UpLoad Time = Oct 15 1999  10:57:19
* Testing adding header lines
* Must start with an asterisk
* Place anywhere between System Upload Time & END of header
* NMEA Latitude = 30 59.70 N
* NMEA Longitude = 081 37.93 W
* NMEA UTC (Time) = Oct 15 1999  10:57:19
* Store Lat/Lon Data = Append to Every Scan and Append to .NAV
File When <Ctrl F7> is Pressed
** Ship:       Sea-Bird
** Cruise:     Sea-Bird Header Test
** Station:
** Latitude:
** Longitude:
*END*
```

5. In the File menu, select Save (**not** Save As). If you are running Windows 2000, the following message displays:
   ```
   You are about to save the document in a Text-Only format,
   which will remove all formatting. Are you sure you want to
   do this?
   ```
   Ignore the message and click *Yes*.
6. In the File menu, select Exit.

Section 6: Routine Maintenance and Calibration

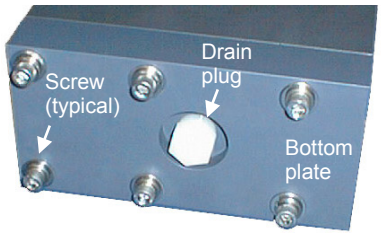
This section reviews corrosion precautions, conductivity cell cleaning and storage, replacement of the Anti-Foulant Device, and sensor calibration. The accuracy of the MicroTSG is sustained by the care and calibration of the sensors and by establishing proper handling practices.

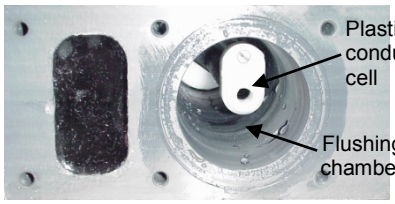
Corrosion Precautions

All hardware exposed to seawater is titanium; the housing is plastic. No corrosion precautions are required. The MicroTSG should be cleaned after use and prior to storage, as described in *Cleaning and Storage*.

Cleaning and Storage

CAUTION:
The MicroTSG's conductivity cell is shipped dry to prevent freezing in shipping. **Do not store the MicroTSG with water in the conductivity cell.** Freezing temperatures (for example, in Arctic environments or during air shipment) can break the cell if it is full of water.





CAUTION:
- **Do not put a brush or any object inside the cell.**
- **Do not spray any solutions directly into the open end of the cell.**

If fouling remains in the conductivity cell after these procedures, return the MicroTSG to Sea-Bird for internal cleaning and recalibration.

Clean the MicroTSG and conductivity cell:
- Monthly (during sustained use)
- Before periods of non-use – If the cell is not rinsed between usage, salt crystals may form on the platinized electrode surfaces. When the instrument is used next, sensor accuracy may be temporarily affected until these crystals dissolve.
- If the data looks incorrect –
  - Unusually *noisy* data may be caused by debris going through the cell.
  - Unusually *smooth* data may be caused by a blockage in the flow path or in the cell.
  - Shifted data may be caused by fouling inside the cell.

Follow this cleaning procedure:

Step 1: Clean Out Drain

A. Keeping the MicroTSG in an upright position, remove the drain plug from the housing's bottom plate.
B. Allow any water to drain out and remove any sediment or debris from the drain.

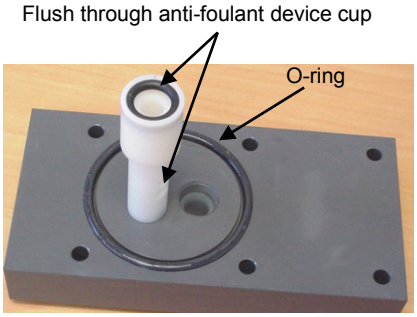
Step 2: Inspect and Clean Flushing Chamber

A. Remove the bottom plate:
   i. Remove the six 1/4-inch socket head screws, lock washers, and flat washers securing the plate to the housing body. Hold the bottom plate as you remove the hardware, to prevent the plate from falling.
   ii. Pull the bottom plate straight down from the housing body, being careful not to damage the conductivity cell, which sits in the housing.
B. Use a flashlight to inspect the flushing chamber and conductivity cell for debris or fine deposits. If this is a routine monthly maintenance, and there is no evidence of debris or fine deposits, proceed to *Step 4: Clean Bottom Plate Assembly*.
C. Gently spray fresh water up into the chamber to remove any fine deposits inside the housing. Be careful not to hit the conductivity cell with the spray hose.

Step 3: Flush Inside of Conductivity Cell

A. Remove the external plumbing connecting the seawater intake and drain lines to the MicroTSG.
B. Clean the inside of the conductivity cell with a series of slow back flushes into the **OUT** port (reverse of the normal operation flow). Collect the drainage in a bucket held below the open housing:
   - **Refer to *Application Note 2D: Instructions for Care and Cleaning of Conductivity Cells* for conductivity cell cleaning materials and concentrations.**
   - The Active Use (after each cast) section of the application note is not applicable to the MicroTSG.
C. If the MicroTSG is being stored, gently blow-dry the conductivity cell and flushing chamber. **Do not use compressed air**, which typically contains oil vapor.
D. Reinstall the external plumbing connecting the seawater intake and drain lines to the MicroTSG.

Step 4: Clean Bottom Plate Assembly



A. Remove the O-ring on the bottom plate. Put the O-ring aside, being careful to protect it from damage or contamination.
B. Flush the anti-foulant device cup on the bottom plate with fresh water, to remove any debris or fine deposits. See *Replacing Anti-Foulant Device* for details on touching or handling the AF24173 Anti-Foulant Device.
C. Rinse the bottom plate with fresh water.
D. Remove water from the O-ring and the bottom plate with a lint-free cloth or tissue.
E. Inspect the O-ring and mating surfaces for dirt, nicks, and cuts. Clean as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to the O-ring and mating surfaces.
F. Replace the O-ring on the bottom plate.

Note:
Early versions of the SBE 45 had a rectangular O-ring in addition to the round O-ring on the bottom plate; see the photo in *Replacing Anti-Foulant Device (SBE 45)*.

CAUTION:
Do not use Parker O-Lube, which is petroleum based; use only *Super* O-Lube.

Step 5: Reinstall Bottom Plate

A. Align the bottom plate with the housing body, ensuring the end of the anti-foulant device cup is aligned with the conductivity cell. Slowly position the bottom plate on the housing.
B. Re-secure the bottom plate to the housing body with the six 1/4-inch socket head screws, lock washers, and flat washers.
C. Reinstall the drain plug in the bottom plate.

CAUTION:
- If you remove sensors and electronics from the housing to troubleshoot, **avoid getting anything on the PCB**, which can be damaged by water or other materials. See *Appendix II: Electronics Disassembly/ Reassembly*.
- **Do not put any object inside the conductivity cell to clean it.** Return the MicroTSG to Sea-Bird for internal cleaning and recalibration.

If the data still looks incorrect after cleaning, it may be caused by:
- a problem with the electrical connections
- a problem with the PCB
- internal fouling in the conductivity cell that was not removed by flushing
- sensors that need to be recalibrated

Replacing Anti-Foulant Device (SBE 45)

AF24173
Anti-Foulant
Device

The MicroTSG has an anti-foulant device cup inside the housing. New MicroTSGs are shipped with an Anti-Foulant Device pre-installed in the cup.

Anti-Foulant Devices are sold packaged in pairs. The second device should be retained as a spare; reseal in its original plastic bag and store in a cool location.

WARNING!

AF24173 Anti-Foulant Devices contain bis(tributyltin) oxide. Handle the devices only with rubber or latex gloves. Wear eye protection. Wash with soap and water after handling.

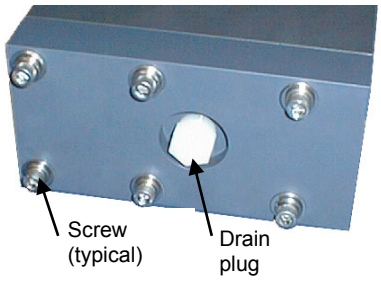
Read precautionary information on product label (see Appendix IV) before proceeding.

It is a violation of US Federal Law to use this product in a manner inconsistent with its labeling.

Wearing rubber or latex gloves, follow this procedure:

1. Keeping the MicroTSG in an upright position, remove the drain plug from the housing's bottom plate. Allow any water to drain out and remove any sediment or debris from the drain before proceeding.

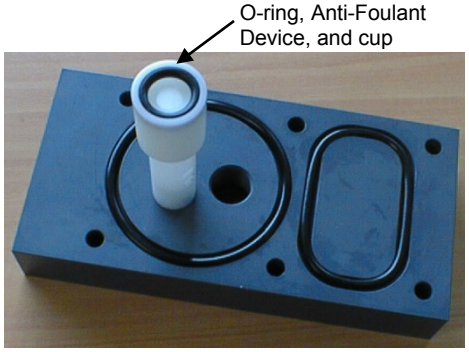
2. Remove the bottom plate:
   A. Remove the six 1/4-inch socket head screws, lock washers, and flat washers securing the bottom plate to the housing body. Hold the bottom plate as you remove the hardware, to prevent it from falling.
   B. Pull the bottom plate straight down from the housing body, being careful not to damage the conductivity cell, which sits in the housing at the end of the anti-foulant device cup.



3. Remove the Anti-Foulant Device:
   A. Place the bottom plate on a horizontal surface. Remove the small O-ring securing the Anti-Foulant Device in the anti-foulant device cup.
   B. Remove the old Anti-Foulant Device. If it is difficult to remove, use needle-nose pliers and carefully break up the material.

CAUTION:
Do not use Parker O-Lube, which is petroleum based; use only *Super* O-Lube.

4. Clean the bottom plate assembly:
   A. Remove the two O-rings on the bottom plate. Put the O-rings aside, being careful to protect them from damage or contamination.
   B. Rinse the bottom plate and flush the inside of the anti-foulant device cup and post with fresh water to remove sediment or debris.
   C. Remove water from the O-rings and the bottom plate with a lint-free cloth or tissue.
   D. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to the O-rings and mating surfaces.
   E. Replace the O-rings on the bottom plate.



5. Place the new Anti-Foulant Device in the cup, and replace the O-ring.

6. Reinstall the bottom plate:
   A. Align the bottom plate with the housing body, ensuring the end of the Anti-Foulant Device cup is aligned with the conductivity cell. Slowly position the bottom plate on the housing.
   B. Re-secure the bottom plate to the housing body with the six 1/4-inch socket head screws, lock washers, and flat washers.
   C. Reinstall the drain plug in the bottom plate.

O-Ring Maintenance

Note:
For details on recommended practices for cleaning, handling, lubricating, and installing O-rings, see the *Basic Maintenance of Sea-Bird Equipment* module in the Sea-Bird training materials on our website.

CAUTION:
Do not use Parker O-Lube, which is petroleum based; use only *Super* O-Lube.

Recommended inspection and replacement schedule:
- Inspect each time you open the housing to clean the MicroTSG and conductivity cell, or to replace the Anti-Foulant Device; replace approximately once a year.

Remove any water from the O-rings and mating surfaces in the housing with a lint-free cloth or tissue. Inspect O-rings and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-rings and mating surfaces.

Sensor Calibration

Note:
Do not disassemble the MicroTSG to send the sensors to Sea-Bird for recalibration. Package the entire MicroTSG for shipment, after removing the AF24173 Anti-Foulant Device (see *Replacing Anti-Foulant Device*). Store the AF24173 Anti-Foulant Device for future use.

Sea-Bird sensors are calibrated by subjecting them to known physical conditions and measuring the sensor responses. Coefficients are then computed which may be used with appropriate algorithms to obtain engineering units. The conductivity and temperature sensors on the MicroTSG are supplied fully calibrated, with coefficients printed on their respective Calibration Certificates (see back of manual). These coefficients have been stored in the MicroTSG's EEPROM.

We recommend that MicroTSGs be returned to Sea-Bird for calibration.

Conductivity Sensor Calibration

The conductivity sensor incorporates a fixed precision resistor in parallel with the cell. When the cell is dry and in air, the sensor's electrical circuitry outputs a frequency representative of the fixed resistor. This frequency is recorded on the Calibration Certificate and should remain stable (within 1 Hz) over time.

The primary mechanism for calibration drift in conductivity sensors is the fouling of the cell by chemical or biological deposits. Fouling changes the cell geometry, resulting in a shift in cell constant.

Accordingly, the most important determinant of long-term sensor accuracy is the cleanliness of the cell. We recommend that the conductivity sensors be calibrated before and after deployment, but particularly when the cell has been exposed to contamination by oil slicks or biological material.

Temperature Sensor Calibration

The primary source of temperature sensor calibration drift is the aging of the thermistor element. Sensor drift will usually be a few thousandths of a degree during the first year, and less in subsequent intervals. Sensor drift is not substantially dependent upon the environmental conditions of use, and — unlike platinum or copper elements — the thermistor is insensitive to shock.

Section 7: Troubleshooting

Note:
See the *PN 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box* manual for additional troubleshooting steps when interfacing with the Box.

This section reviews common problems in operating the MicroTSG, and provides the most common causes and solutions.

Problem 1: Unable to Communicate with MicroTSG

The S> prompt indicates that communications between the MicroTSG and computer have been established. Before proceeding with troubleshooting, attempt to establish communications again by clicking Connect on Seaterm's toolbar or hitting the Enter key several times.

Cause/Solution 1: The I/O cable connection may be loose. Check the cabling between the MicroTSG and computer (or optional Interface Box) for a loose connection.

Cause/Solution 2: The instrument type and/or its communication settings may not have been entered correctly in Seaterm. Select the SBE 45 in the Configure menu and verify the settings in the Configuration Options dialog box. The settings should match those on the instrument Configuration Sheet.

Cause/Solution 3: The I/O cable may not be the correct one. Verify the cable is the correct one.

Problem 2: Unable to View Data in Seasave (Real-Time Data Acquisition program)

Note:
If *Check scan length* is enabled in Seasave's Options menu, Seasave checks the data scan length against the expected length (based on the configuration file setup), and provides a warning that there is an error. Sea-Bird recommends using this setting.

Cause/Solution 1: If the scan length does not match the selected .xmlcon or .con configuration file (for example, the configuration file indicates that NMEA position data is added through the junction box connected to the MicroTSG, but you did not connect the NMEA device to the junction box), **Seasave continues with real-time data acquisition (saving the raw data to a file for later processing), but does not show or plot data in the Seasave displays.** The data quality is not affected; you can correct the configuration file error in SBE Data Processing (post-processing), and process the data as required.

Problem 3: Scan Length Error in SBE Data Processing

Note:
To view the Diagnostics file, select *Diagnostics* in Data Conversion's Options menu. In the Diagnostics dialog box, click on *Display Log File*.

Cause/Solution 1: If the scan length in the data file does not match the selected .xmlcon or .con configuration file (for example, the configuration file indicates that NMEA position data was added, but the data file does not contain NMEA data), SBE Data Processing's Data Conversion module will not process the data. If you look in the Diagnostics file, you will see a *scan length error*. Check the configuration file against the header in the data file, and correct the configuration file as required.

Problem 4: Nonsense or Unreasonable Data

The symptom of this problem is data that contains nonsense values (for example, 9999.999) or unreasonable values (for example, values that are outside the expected range of the data).

Cause/Solution 1: A data file with nonsense values may be caused by incorrect instrument configuration in the .xmlcon or .con file. Verify the settings in the configuration file match your system.

Cause/Solution 2: Unreasonable values may be caused by incorrect calibration coefficients programmed into the MicroTSG. Verify the coefficients match the instrument Calibration Certificates, using **DC**.

Problem 5: Salinity Lower than Expected

Cause/Solution 1: A fouled conductivity cell will report lower than correct salinity. Large errors in salinity indicate that the cell is extremely dirty, has something large lodged in it, or is broken. Proceed as follows:

1. Clean the conductivity cell as described in *Cleaning and Storage* in *Section 6: Routine Maintenance and Calibration*.
2. Remove larger droplets of water by blowing through the conductivity cell. **Do not use compressed air**, which typically contains oil vapor.
3. Running the MicroTSG in air, use **TSR** to look at the raw conductivity frequency. It should be within 1 Hz of the zero conductivity value printed on the conductivity cell Calibration Sheet. If it is significantly different, the cell is probably damaged.

Glossary

Note:
See the Interface Box manual for operation of the MicroTSG with the Interface Box. The Interface Box can be added to the system at any time, and does not need to be part of the original MicroTSG order.
- **The Interface Box must be placed in a mode to communicate with the MicroTSG (Connect45 command) before you send commands through the Interface Box to the MicroTSG.**

Fouling – Biological growth in the conductivity cell during deployment.

PN 90402 - SBE 45 Power, Navigation, and Remote Temperature Interface Box – Optional Box provides:
- Power and an opto-isolated RS-232C interface for the MicroTSG
- An opto-isolated NMEA receiver for a NMEA navigation device (NMEA navigation device not supplied by Sea-Bird)
- Power and an RS-232C interface for an SBE 38 remote temperature sensor
- An RS-232 computer interface

PCB – Printed Circuit Board.

Scan – One data sample containing temperature and conductivity, as well as derived variables (salinity and sound velocity).

SBE 45 MicroTSG – High-accuracy conductivity and temperature monitor.

SBE Data Processing – Sea-Bird's Win 2000/XP data processing software, which calculates temperature and conductivity, as well as data from auxiliary sensors, and derives variables such as salinity and sound velocity.

Seasave V7 – Sea-Bird's Windows 2000/XP software used to acquire, convert, and display real-time or archived raw data.

Seasoft V2– Sea-Bird's complete Windows 2000/XP software package, which includes software for communication, real-time data acquisition, and data analysis and display. Seasoft V2 includes ***Seaterm***, ***Seasave V7***, ***SBE Data Processing***.

Seaterm – Sea-Bird's Win 95/98/NT/2000/XP terminal program used to communicate with the MicroTSG. Seaterm can send commands to the MicroTSG to provide status display, data acquisition setup, data display and capture, and diagnostic tests.

CAUTION:
Do not use Parker O-Lube, which is petroleum based; use only *Super* O-Lube.

Super O-Lube – Silicone lubricant used to lubricate O-rings and O-ring mating surfaces. Super O-Lube can be ordered from Sea-Bird, but should also be available locally from distributors. Super O-Lube is manufactured by Parker Hannifin (www.parker.com/ead/cm2.asp?cmid=3956).

TCXO – Temperature Compensated Crystal Oscillator.

Triton X-100 – Reagent grade non-ionic surfactant (detergent), used for cleaning the conductivity cell. Triton can be ordered from Sea-Bird, but should also be available locally from chemical supply or laboratory products companies. Triton is manufactured by Avantor Performance Materials (www.avantormaterials.com/commerce/product.aspx?id=2147509608).

Appendix I: Functional Description

Sensors

The MicroTSG embodies the same sensor elements (3-electrode, 2-terminal, borosilicate glass cell, and pressure-protected thermistor) previously employed in Sea-Bird's modular SBE 3 and SBE 4 sensors, in the SEACAT and SEACAT *plus* family, and in the SBE 37 MicroCAT family.

Sensor Interface

Temperature is acquired by applying an AC excitation to a hermetically-sealed VISHAY reference resistor and an ultra-stable aged thermistor with a drift rate of less than 0.002 °C per year. A 24-bit A/D converter digitizes the outputs of the reference resistor and thermistor. AC excitation and ratiometric comparison using a common processing channel avoids errors caused by parasitic thermocouples, offset voltages, leakage currents, and reference errors.

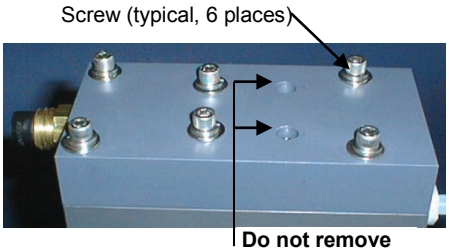
Conductivity is acquired using an ultra-precision Wein Bridge oscillator to generate a frequency output in response to changes in conductivity. A high stability TCXO reference crystal with a drift rate of less than 2 ppm/year is used to count the frequency from the Wein Bridge oscillator.

Appendix II: Electronics Disassembly/Reassembly

Note:
Do not disassemble the MicroTSG to send the sensors or PCB to Sea-Bird for recalibration or repair. Package the entire MicroTSG for shipment, after removing the AF24173 Anti-Foulant Device (see *Section 6: Routine Maintenance and Calibration*).

Do not disassemble the MicroTSG electronics unless:
- moving the J1 jumper on the PCB to change operation from Autopower (default) to Normal, or vice versa, or
- troubleshooting a problem, requiring access to the PCB or sensors

Disassembly



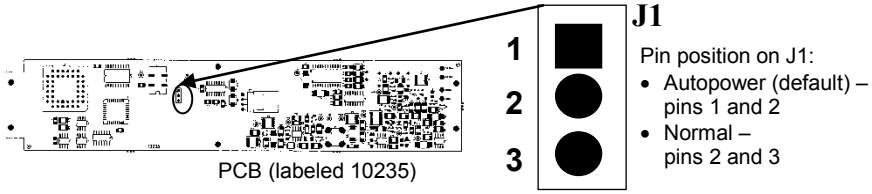
CAUTION:
Avoid getting anything on the PCB, which can be damaged by water or other materials.

1. Remove the six 1/4-inch socket head screws, lock washers, and flat washers securing the top plate to the housing body. **Do not remove the two screws that are recessed in the top plate – these secure the electronics to the top plate**.

2. Remove the top plate by pulling up on it firmly and steadily. It may be necessary to **slightly** twist the top plate back and forth to loosen the o-ring seals. Lift the top plate vertically off the housing body, **being careful not to hit the conductivity cell on the housing body.**

3. Remove any water from the O-ring mating surfaces on the top plate assembly and on the housing with a lint-free cloth or tissue.

4. If applicable, verify/change J1 jumper setting.



Pin position on J1:
- Autopower (default) – pins 1 and 2
- Normal – pins 2 and 3

Reassembly

Note:
Before delivery, a desiccant package is placed in the electronic chamber, and the chamber is filled with dry Argon gas. These measures help prevent condensation. To ensure proper functioning:
1. Install a new desiccant bag each time you open the housing. If a new bag is not available, see *Application Note 71: Desiccant Use and Regeneration (drying)*.
2. If possible, dry gas backfill each time you open the housing. If you cannot, wait at least 24 hours before redeploying, to allow the desiccant to remove any moisture.

CAUTION:
Do not use Parker O-Lube, which is petroleum based; use only *Super* O-Lube.

1. Remove any water from the O-rings and mating surfaces with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-rings and mating surfaces.

2. Align the top plate with the housing body, with the conductivity cell's round end cap aligned with the round opening in the housing body. Slowly lower the top plate, checking that it remains aligned with the housing body. You will feel resistance as the O-rings on the sensor end cap enter the housing.

3. Re-secure the top plate to the housing body with the six 1/4-inch socket head screws, lock washers, and flat washers.

Appendix III: Command Summary

Note:
See the Interface Box manual for operation of the MicroTSG with the Interface Box. The Interface Box can be added to the system at any time, and does not need to be part of the original MicroTSG order.

- **The Interface Box must be placed in a mode to communicate with the MicroTSG (Connect45 command) before you send commands through the Interface Box to the MicroTSG.**

CATEGORY	COMMAND	DESCRIPTION
Status	**DS**	Display status.
Setup	**Baud=x**	**x=** baud rate (1200, 2400, 4800, 9600, 19200, or 38400). Default 4800.
	OutputFormat=x	**x=0** (default): Output temperature, conductivity, salinity, sound velocity. **x=1**: Suppress space before conductivity output. **x=2**: Output temperature, salinity, conductivity, sound velocity (not for use with Seasave, SBE Data Processing, or optional Interface Box).
	OutputCond=x	**x=Y** (default): Output conductivity (S/m) with data. **x=N**: Do not.
	OutputSal=x	**x=Y**: Output salinity (psu) with data. **x=N** (default): Do not.
	OutputSV=x	**x=Y**: Output sound velocity (m/sec) with data, calculated as defined by **SVAlgorithm=**. **x=N** (default): Do not.
	SVAlgorithm=x	**x=C** (default): Calculate Chen and Millero sound velocity. **x=W**: Calculate Wilson sound velocity.
	NCycles=x	**x** = A/D cycles to average per sample (default=4).
	QS	Quit session and place MicroTSG in quiescent (sleep) state. Sampling stops. Applicable only if PCB J1 jumper in Normal position.
Operating PCB's J1 jumper interacts with these commands: • Autopower – pins 1 and 2 • Normal – pins 2 and 3	**Interval=x**	**x=** interval (seconds) between samples (maximum 32767). Minimum time between samples determined by **NCycles=**, desired parameters (salinity, etc.), and baud rate.
	AutoOff=x	**(Functional only if J1 jumper in Normal position)** **x=Y**: Go to sleep (enter quiescent state) if 2 minutes have elapsed without receiving a command or without sampling data. **x=N**: Do not automatically go to sleep.
	J1 jumper - Normal **AutoRun=N** **SingleSample=** **Y** or **N**	Wake up when Connect on Toolbar clicked or Enter key pressed while in quiescent (sleep) state, wait for a command.
	J1 jumper - Normal **AutoRun=Y** **SingleSample=N**	Wake up when Connect on Toolbar clicked or Enter key pressed while in quiescent (sleep) state, sample at rate specified by **Interval=**. To stop sampling and get `S>` prompt, type **Stop** and press Enter key.
	J1 jumper - Normal **AutoRun=Y** **SingleSample=Y**	Wake up when Connect on Toolbar clicked or Enter key pressed while in quiescent (sleep) state, take and output a single sample, automatically go to sleep. To wake up and get `S>` prompt, type **Stop** and press Enter key.
	J1 jumper - Autopower **AutoRun=N** **SingleSample=Y** or **N**	Wake up when power applied, wait for a command.
	J1 jumper - Autopower **AutoRun=Y** **SingleSample=N**	Wake up when power applied, sample at rate specified by **Interval=** until power removed. **Required settings for running MicroTSG in 3-wire (power, ground, transmit) configuration or with Interface Box**.
	J1 jumper - Autopower **AutoRun=Y** **SingleSample=Y**	Wake up when power applied, take and output a single sample. Wait for another command until power removed.
	Go	Start sampling, as defined by **SingleSample=** and **Interval=**. Applicable if **AutoRun=N**, or **AutoRun=Y** and you previously sent **Stop** to stop sampling.
	Stop	Stop sampling.

CATEGORY	COMMAND	DESCRIPTION
Polled Sampling Do not send these commands if MicroTSG is sampling data at pre-programmed intervals.	**TS**	Take sample, hold converted data in RAM, output converted data
	TSR	Take sample, hold raw data in RAM, output raw data.
	SLT	Send converted data from last sample in RAM, then take new sample and hold converted data in RAM.
	TH	Take sample, hold converted data in RAM.
	SH	Send held converted data from RAM.
Testing	**TT**	Measure temperature 100 times or until Esc key is pressed, output converted data.
	TC	Measure conductivity 100 times or until Esc key is pressed, output converted data.
	TTR	Measure temperature 100 times or until Esc key is pressed, output raw data
	TCR	Measure conductivity 100 times or until Esc key is pressed, output raw data.
Calibration Coefficients (F=floating point number; S=string with no spaces) Dates shown are when calibrations were performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with MicroTSGs.	**DC**	Display calibration coefficients; all coefficients and dates listed below are included in display. Use individual commands below to modify a particular coefficient or date.
	TCalDate=S	**S**=Temperature calibration date.
	TA0=F	**F**=Temperature A0.
	TA1=F	**F**=Temperature A1.
	TA2=F	**F**=Temperature A2.
	TA3=F	**F**=Temperature A3.
	CCalDate=S	**S**=Conductivity calibration date.
	CG=F	**F**=Conductivity G.
	CH=F	**F**=Conductivity H.
	CI=F	**F**=Conductivity I.
	CJ=F	**F**=Conductivity J.
	WBOTC=F	**F**=Conductivity wbotc.
	CTCor=F	**F**=Conductivity ctcor.
	CPCor=F	**F**=Conductivity cpcor.

Appendix IV: AF24173 Anti-Foulant Device

AF24173 Anti-Foulant Devices supplied for user replacement are supplied in polyethylene bags displaying the following label:

AF24173 ANTI-FOULANT DEVICE

FOR USE ONLY IN SEA-BIRD ELECTRONICS' CONDUCTIVITY SENSORS TO CONTROL THE GROWTH OF AQUATIC ORGANISMS WITHIN ELECTRONIC CONDUCTIVITY SENSORS.

ACTIVE INGREDIENT:

Bis(tributyltin) oxide…….……....	53.0%
OTHER INGREDIENTS: …….....	47.0%
Total…….....	100.0%

DANGER

See the complete label within the Conductivity Instrument Manual for Additional Precautionary Statements and Information on the Handling, Storage, and Disposal of this Product.

Net Contents: Two anti-foulant devices

Sea-Bird Electronics, Inc.
13431 NE 20th Street
Bellevue, WA 98005

EPA Registration No. 74489-1
EPA Establishment No. 74489-WA-1

AF24173 Anti-Foulant Device

FOR USE ONLY IN SEA-BIRD ELECTRONICS' CONDUCTIVITY SENSORS TO CONTROL THE GROWTH OF AQUATIC ORGANISMS WITHIN ELECTRONIC CONDUCTIVITY SENSORS.

ACTIVE INGREDIENT:
Bis(tributyltin) oxide……..……..... 53.0%
OTHER INGREDIENTS: ……..... 47.0%
Total……..... 100.0%

DANGER
See Precautionary Statements for additional information.

FIRST AID	
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for15-20 minutes. • Call a poison control center or doctor for treatment advice.
If swallowed	• Call poison control center or doctor immediately for treatment advice. • Have person drink several glasses of water. • Do not induce vomiting. • Do not give anything by mouth to an unconscious person.
If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
HOT LINE NUMBER	
Note to Physician	Probable mucosal damage may contraindicate the use of gastric lavage.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For further information call National Pesticide Telecommunications Network (NPTN) at 1-800-858-7378.	

Net Contents: Two anti-foulant devices

Sea-Bird Electronics, Inc.
13431 NE 20th Street
Bellevue, WA 98005

EPA Registration No. 74489-1
EPA Establishment No. 74489-WA-1

PRECAUTIONARY STATEMENTS

HAZARD TO HUMANS AND DOMESTIC ANIMALS

DANGER

Corrosive - Causes irreversible eye damage and skin burns. Harmful if swallowed. Harmful if absorbed through the skin or inhaled. Prolonged or frequently repeated contact may cause allergic reactions in some individuals. Wash thoroughly with soap and water after handling.

PERSONAL PROTECTIVE EQUIPMENT

USER SAFETY RECOMMENDATIONS

Users should:

- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Wear protective gloves (rubber or latex), goggles or other eye protection, and clothing to minimize contact.
- Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.
- Wash hands with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet.

ENVIRONMENTAL HAZARDS

Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of EPA. This material is toxic to fish. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

PHYSICAL OR CHEMICAL HAZARDS

Do not use or store near heat or open flame. Avoid contact with acids and oxidizers.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling. For use only in Sea-Bird Electronics' conductivity sensors. Read installation instructions in the applicable Conductivity Instrument Manual.

STORAGE AND DISPOSAL

PESTICIDE STORAGE: Store in original container in a cool, dry place. Prevent exposure to heat or flame. Do not store near acids or oxidizers. Keep container tightly closed.

PESTICIDE SPILL PROCEDURE: In case of a spill, absorb spills with absorbent material. Put saturated absorbent material to a labeled container for treatment or disposal.

PESTICIDE DISPOSAL: Pesticide that cannot be used according to label instructions must be disposed of according to Federal or approved State procedures under Subtitle C of the Resource Conservation and Recovery Act.

CONTAINER HANDLING: Nonrefillable container. Do not reuse this container for any other purpose. Offer for recycling, if available.

Sea-Bird Electronics/label revised 01-28-10

Appendix V: Replacement Parts

Part Number	Part	Application Description	Quantity in MicroTSG
30541	3/8" NPT to Hose Barb Fitting for 3/8" Tygon tubing, Parker, N6MCB6	Intake and exhaust nozzles on water jacket	2
801542.1	AF24173 Anti-Foulant Device	Bis(tributyltin) oxide device inserted into anti-foulant device cup	1
30411	Triton X-100	Octyl Phenol Ethoxylate – Reagent grade non-ionic cleaning solution for conductivity cell (supplied in 100% strength; dilute as directed)	1
801392	4-pin MCIL-4MP to 9-pin DB-9S I/O cable with power leads, 2.4 m (8 ft) long	From MicroTSG to computer	1
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	1
60036	Spare hardware/ O-ring kit	Assorted hardware and O-rings, including: • 31132 Cap screw, 1/4-20 x 1 3/4", 316 stainless steel (secures top and bottom plates to housing body) • 30254 Washer, 1/4" split ring lock, stainless steel (for screw 31132) • 30570 Washer, 1/4" flat, stainless steel (for screw 31132) • 31057 O-ring, Parker 2-229N674-70 (round seal between bottom plate and housing) • 31062 Plug N6HPL, 3/8 NPT Nylon (drain plug for bottom plate)	-
30507	O-ring, Parker 2-206N674-70	Seal for conductivity cell end, secures AF24173 Anti-Foulant Device in anti-foulant device cup	1
31058	O-ring, Parker 2-239N674-70	Large seal for top plate to housing body	1
30818	O-ring, Parker 2-203N674-70	Seal for top plate to housing body center screws	2

Appendix VI: Manual Revision History

Manual Version	Date	Description
001	02/00	• Initial release of production units.
002	04/00	• Remove 'optically isolated' from description of RS-232 link (conductivity circuit is electrically isolated, not the data lines).
003	08/00	• Remove reference to RS-485 communication, not available.
004	12/02	• Correct format for sound velocity was vvvvv.vvv; corrected to vvvv.vvv. • Update information on Anti-foulant replacement. • Add more information on data output format. • Add more information about where / how to place SBE 45 and pump, debubblers, etc. • Add more information on data transmission rate, cable length, and baud rate.
005	01/03	• Add anti-foul label pages in appendix.
006	03/03	• Add information on new compatibility with Seasave. • Add information on use of 45 with 90402 Interface Box for acquiring remote temperature and NMEA navigation data.
007	03/04	• Add missing dimensions on drawing. • Correct info on nylon hose barb fitting – it's for 3/8" (not ½") tubing. • Update Seaterm screens.
008	09/04	• 1.1 Firmware: Add **OutputFormat=** command.
009	01/05	• Change factory default baud to 4800 from 9600; makes SBE 45 compatible with interface box factory default, which is 9600 and must be > SBE 45 baud. • Internal design change: Update photo of topside of bottom plate assembly.
010	06/05	• Update AF24173 Anti-Foulant Device appendix to current label. • Update cleaning recommendations to correspond to revised application note 2D. • Add information about using remote Temperature sensor: Seasave, Data Conversion, and Derive all use remote temperature sensor data when calculating density and sound velocity.
011	06/05	• 1.1a Firmware: add **SVAlgorithm=** command: If **SVAlgorithm=w**: use wilson algorithm to calculate sound velocity, If **SVAlgorithm=c**: use chen-millero algorithm to calculate sound velocity • Internal design change: Update photo in electronics assembly / disassembly showing C cell, photo in cleaning & storage showing flushing chamber • Update Triton website URL
012	05/07	• Incorporate Seasave V7
013	06/08	• 1.1b Firmware: add **OutputFormat=2** command (same as **OutputFormat=0**, but reverse salinity and conductivity order)
014	12/09	• Update for Seasave/SBE Data Processing 7.18, configuration file now allows selection of NMEA connected directly to the computer. • Update interface box photo (redesigned box) • Update software name. • Add CE mark and information required for certification. • List new address.
015	01/10	• Seasave and SBE Data Processing 7.20a: Add information about .xmlcon file. • Update anti-foul label in Appendix with new Container Handling requirement and new address
016	07/12	• Add more notes about using the Interface Box manual if integrating with the Interface Box, and using the **Connect45** command to connect to the SBE 45 through the Interface Box. • Add more troubleshooting information on scan length errors. • Correct installation dimensions to provide more significant digits. • Update company name and URL for Triton. • Correct typos.
017	09/12	• Add cable drawing and internal wiring drawing.
018	09/13	• Clarify that accuracy specifications are ±. • Update Declaration of Conformity. • Remove references to old Seasave-Win32 software.

Continued on next page

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019	02/15	• Add sampling rate to specifications. • Add information on O-ring maintenance. • Add caution regarding using spray can lubricants on MCBH connectors. • Add caution regarding using Parker Super O Lube, not Parker O Lube (which is petroleum based). • Update language on where to find software on website. • Switch to Sea-Bird Scientific cover.

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